In the United States Court of Federal Claims

OFFICE OF SPECIAL MASTERS

Filed: May 22, 2023

DUANE MORGAN,	*	Published
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	*	No. 16-269V
Petitioner,	*	
v.	*	Special Master Gowen
	*	
SECRETARY OF HEALTH AND HUMAN SERVICES,	*	Ruling on Entitlement; Influenza Vaccine; Brachial Neuritis.
	*	
Respondent.	*	

Paul R. Brazil, Muller Brazil, LLP, Dresher, PA, for petitioner.
Ryan D. Pyles, U.S. Dept. of Justice, Washington, D.C., for respondent.

RULING ON ENTITLEMENT[1]

On February 26, 2016, Duane Morgan ("petitioner") filed a petition for compensation in the National Vaccine Injury Compensation Program.[2] Petition (ECF No. 1). Petitioner alleged that as a result of receiving the influenza vaccine on October 22, 2014, he suffered from adhesive capsulitis and brachial neuritis. Amended Petition (ECF No. 26). After a review of the record, petitioner has established by preponderant evidence that he is entitled to compensation.

I. Procedural History

Petitioner filed his claim for compensation on February 26, 2016, alleging that the intradermal flu vaccine caused him to suffer brachial neuritis in his left arm and shoulder.

[1] Pursuant to the E-Government Act of 2002, *see* 44 U.S.C. § 3501 note (2018) (Federal Management and Promotion of Electronic Government Services **because this opinion contains a reasoned explanation for the action in this case, I intend to post it on the website of the United States Court of Federal Claims.** The Court's website is at http://www.uscfc.uscourts.gov/aggregator/sources/7. Before the opinion is posted on the Court's website, each party has 14 days to file a motion requesting redaction "of any information furnished by that party: (1) that is a trade secret or commercial or financial in substance and is privileged or confidential; or (2) that includes medical files or similar files, the disclosure of which would constitute a clearly unwarranted invasion of privacy." Vaccine Rule 18(b). An objecting party must provide the Court with a proposed redacted version of the opinion. *Id*. **If neither party files a motion for redaction within 14 days, the opinion will be posted on the Court's website without any changes.** *Id*.

[2] The National Vaccine Injury Compensation Program is set forth in Part 2 of the National Childhood Vaccine Injury Act of 1986, Pub. L. No. 99-660, 100 Stat. 3755, codified as amended, 42 U.S.C. §§ 300aa-10 to 34 (2012) (hereinafter "Vaccine Act" or "the Act"). Hereinafter, individual section references will be to 42 U.S.C. § 300aa of the Act.

Amended Petition. The petition was accompanied by medical records to support his claim. Petitioner's Exhibits ("Pet. Exs.") 1-7.

On July 27, 2016, respondent filed the Rule 4c report stating that this case was not appropriate for compensation. Respondent's ("Resp") Report ("Rept.") (ECF No. 16). Respondent stated that the medical records demonstrate that petitioner received the flu vaccine administered intradermally (not subcutaneously nor intramuscularly), and that petitioner is alleging injuries "to structures deep within the shoulder joint," which "the vaccine administration method used here could not have impacted." *Id*. at 9. Respondent also asserted that petitioner's report written by Dr. Russell Huffman "fails to even mention the method of vaccine administration, much less address how an intradermal vaccine could cause the petitioner's injuries." *Id*. at 9. Additionally, respondent questioned the onset of petitioner's shoulder pain. *Id*.

Petitioner filed an expert report from his treating orthopedist, Russell Huffman, MD, MPH on December 19, 2016. Pet. Ex. 8 (ECF No. 24).[3] Dr. Huffman, petitioner's treating orthopedic surgeon, opined that petitioner's left shoulder symptoms and injury was caused by the flu vaccination petitioner received on October 22, 2014. Pet. Ex. 8 at 1. Petitioner amended his petition on January 4, 2017.

The case was reassigned to my docket on March 6, 2017 and a status conference was held on March 30, 2017. During the status conference, I explained that petitioner's alleged injuries "suggested the likelihood of an inflammatory process," and I recommended that petitioner obtain an appropriate expert to discuss the causal mechanism. Scheduling Order (ECF No. 33).

Petitioner filed an expert report by Vera Byers, M.D.[4] on June 28, 2017. Pet. Ex. 9 (ECF No. 34). Respondent filed an expert report by Dr. Noel Rose on September 15, 2017. Resp. Ex.

[3] Dr. G Russell Huffman is a practicing orthopaedic surgeon. Pet. Ex. 40 at 1. He received his undergraduate degree from Davidson College in 1992 and his medical degree from Duke University School of Medicine in 1998. *Id*. Following graduation, he had a surgical internship at the University of California San Francisco and completed his residency in orthopaedic surgery in 2003. *Id*. Dr. Huffman is licensed to practice medicine in California and Pennsylvania. *Id*. at 2. In 2005, he became and is still an attending orthopaedic surgeon at Penn Presbyterian Medical Center and the University of Pennsylvania Hospital. *Id*. at 1. He is the director of the University of Pennsylvania Shoulder and Elbow Fellowship program. *Id*. at 1. Dr. Huffman is an editorial member of multiple orthopapedic focused journals, including the Journal of Shoulder and Elbow Surgery and the American Journal of Sports Medicine. *Id*. at 3. He has been the led author or co-authored multiple research publications on varying topics related to orthopadics. *Id*. at 12-16. Given Dr. Huffman's credentials in the field of orthopadics, he is accepted as an expert in the field of orthopadics.

[4] Dr. Byers received Ph.D. in immunology in 1969 from the University of California and received her medical degree in 1981 from the University of California at San Francisco. Pet. Ex. 39 at 1. Dr. Byers was in private practice seeking patients with allergic and autoimmune diseases, along with cancer from 1984-1987. *Id*. at 3. She is currently the president of Immunology, Inc., where she has designed and run clinical drug trials in autoimmune diseases, HIV, atopic dermatitis, and certain types of cancers. *Id*. at 2. She has had multiple academic positions, and is currently serving as an adjunct professor of Microbiology and Immunology at Texas Tech University. *Id*. at 4. Dr. Byers is a reviewer for Clinical Trial Grant Program at the National Cancer Institute. *Id*. at 5. Further, Dr. Byers has authored or co-authored numerous medical articles in peer reviewed journals. *Id*. at 6-14. Dr. Byers has testified before in Vaccine Program cases as an expert immunology, thus is accepted as an expert in immunology for this matters as well.

1 (ECF No. 37). I held another status conference on October 10, 2017, where I explained that Dr. Byers had presented a persuasive medical theory of causation and recommended that the parties engage in settlement discussions. Scheduling Order (ECF No. 42).

Respondent opted to continue to defend against petitioner's claim. Therefore, petitioner filed a supplemental responsive expert report by Dr. Byers. Pet. Ex. 10 (ECF No. 47). An entitlement hearing had been set for April 21, 2020. Pre-hearing Order (ECF No. 56).

On January 31, 2020, respondent filed an expert report from Brian Callaghan, M.D.[5], with medical literature on which he relied. Resp. Ex. A (ECF No. 62). Petitioner filed an expert report from Maria Fangchun Chen, M.D., PhD[6], and the medical literature she relied upon. Pet. Ex. 19 (ECF No. 65).

The entitlement hearing for April 21, 2020 was cancelled and I held a status conference on March 30, 2020. Scheduling Order (ECF No. 70). During this status conference, I explained Dr. Chen's report provided additional support to petitioner's theory of vaccine causation. *Id.* at 4. Additionally, I recommended that the parties seek to resolve the case through settlement negotiations. *Id.* at 5.

On May 4, 2021, respondent filed an additional supplemental report from Mark Tompkins, Ph.D[7], and medical literature that was referenced by Dr. Tompkins and another report

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[5] Dr. Callaghan graduated from the University of Michigan with a Bachelor of Science degree in 1996. Resp. Ex. B at 1. He graduated from the University of Pennsylvania Medical Center with a medical degree in 2004. *Id.* He remained at the University of Pennsylvania Medical Center for an internship in preliminary medicine from 2004 – 2005 and a residency in neurology from 2005 – 2008. *Id.* Afterwards, Dr. Callaghan affiliated with the University of Michigan Medical School, at first to accept a fellowship in neuromuscular medicine and to enroll in a master's degree in clinical research design and statistical analysis, which he completed in 2011. *Id.* In 2009, he was hired onto the Michigan faculty, where he is currently an associate professor in neurology. *Id.* Dr. Callaghan stated that he has primary interest in patients with neuropathy, such as brachial neuritis and cervical radiculplexus neuropathy. Resp. Ex. A at 1. He also is the Director of the ALS Clinic at the VA Ann Arbor Health System. Resp. Ex. B at 2. Dr. Callaghan has an extensive list of peer review publications that he authored or was a contributor. *Id.* Thus, Dr. Callaghan is accepted as an expert in neurology.

[6] Dr. Maria Fang-Chun Chen is a neurologist that currently teaches at the Perlman School of Medicine at the University of Pennsylvania Medical School. Pet. Ex. 20, Tab A. Dr. Chen graduated from Louisiana State University in 1999. She received her Ph.D. from the University of Pennsylvania in 2005 and her medical degree from the same in 2007. *Id.* Dr. Chen explained that her Ph. D is in molecular virology. Pet. Ex. 19 at 1. She did her residency in neurology at the Hospital of the University of Pennsylvania. Pet. Ex. 20, Tab A. Dr. Chen's is licensed to practice in Pennsylvania and she is a board certified neurologist. *Id.* at 2. She is currently an Assistant Professor of Clinical Neurology at Penn Medicine. *Id.* In her report, she averred that she sees over 2000 patients in her outpatient clinic at Penn Medicine. Pet. Ex. 19 at 1. Further, she currently has over 200 outpatients with neuropathies in her care. *Id.* Dr. Chen stated that medical-legal consultation contributes 1-5% to her yearly salary. *Id.* Dr. Chen is admitted an expert in neurology in this matter.

[7] Dr. Tompkins graduated from the University of Illinois with a Bachelor of Science degree in 1990. Resp. Ex. D at 1. He graduated from Emory University with a Ph.D. in Immunology in 1997. *Id.* From 1997 to 2002, he held a post-doctoral research position at Northwestern University Medical School. *Id.* at 1, 3. Dr. Tompkins stated that his postdoctoral training has focused on the immunologic mechanisms of induction of autoimmune disease, specifically interrogating antigen-and virus-induced models of experimental encephalomyelitis; models for the neurologic autoimmune disease, multiple sclerosis. Resp. Ex. C at 1. He stated that he has been funded by the NIH and other

from Dr. Callaghan. Resp. Exs. C and E. Petitioner filed a responsive supplemental report from Dr. Chen on June 17, 2021. Pet. Ex. 25 (ECF No. 92).

On July 16, 2021, petitioner filed a motion for a ruling on the record. Pet. Mot. (ECF No. 93). Respondent filed a response on October 15, 2021, agreeing to have the case resolved on the record Resp. Brief (ECF No. 96). On November 19, 2021, petitioner filed a reply to respondent's response. Pet. Reply (ECF No. 97).

This matter is now ripe for adjudication.

II. Evidence Filed

a. Medical Records

Petitioner, a 60-year-old man, presented to Dr. David Peet Jr. on October 22, 2014 for a "re-evaluation of fibromyalgia, chronic stiffness, and severe pain." Pet. Ex. 2 at 79. Under "Review of Systems," petitioner reported that he did not have any neck, joint, or muscle pain. *Id*. His musculoskeletal examination was normal. *Id*. at 81. Petitioner was diagnosed with diabetes mellitus without mention of complication and not uncontrolled and "other chronic pain." *Id*. at 82. He was administered the intradermal flu shot in his left arm.

On January 19, 2015, petitioner had a follow-up appointment with Dr. Peet for a follow-up for his diabetes. Pet. Ex. 2 at 84. His musculoskeletal exam noted normal range of motion, normal strength, and no tenderness. *Id*. at 86. This time, Dr. Peet diagnosed petitioner with diabetes without complication and "myalgia and myositis, unspecified." *Id*. at 87.

On March 2, 2015, petitioner had an appointment with Dr. Michael Barmach for pain in his left shoulder to hand. Pet. Ex. 2 at 89. Under "Chief Complaint," it noted, "[he] received flu shot on 10/22/2014 from our practice. The flu shot was given in the left deltoid, about 3 days after injection, there was some pain, redness, and swelling. Was seen again on 1/19/2015 with Dr. Peet and showed him the lump that had lasted since injection." *Id*. Petitioner reported that he was having pain on the left side of his neck, and it was not relieved with heat. *Id*. He also reported that the pain radiated down to his elbow, numbness in his left hand, and it hurt to move his arm in all directions. *Id*. Petitioner also reported a raised rash around the area of the shot for several weeks. *Id*. He described the pain as "knife-like." *Id*. His physical exam was notable for "palpable muscle spasms along the left trapezius and petitioner was only able to flex his left arm approximately 80 degrees before it became too painful. *Id*. at 91. Further, his neurologic exam showed that petitioner had weakness in his left arm, both proximally and distally, compared to his right arm. *Id*. Dr. Barmach diagnosed petitioner with brachial neuritis or radiculitis. *Id*. Dr. Barmach also wrote, "[Pt] believes symptoms started after flu shot, but I believe more coincidental. I believe symptoms due to neck pathology and getting radicular pain." *Id*. Dr.

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federal agencies since 2007, for research focused on novel vaccines, adjuvants, and therapies, and mechanism of vaccine-or therapeutic-associated protection and diseases. *Id*. Dr. Tompkins is currently a full professor at the University of Georgia, College of Veterinary Medicine, where he spends 80% of his time doing research and 20% teaching. Resp. Ex. D at 2. Additionally, Dr. Tompkins is the Assistant Department Head and Curriculum Coordinator of the Department of Infectious Diseases, College of Veterinary Medicine at the University of Georgia. Dr. Tompkins is accepted as an expert in the subject of immunology.

Barmach prescribed a Medrol dose pack for symptom relief and referred petitioner to an orthopedist for an evaluation. *Id.*

Petitioner had an appointment with orthopedist, Dr. Gracie on March 16, 2015. Pet. Ex. 3 at 5. Petitioner reported he had left shoulder pain for five months. *Id.* He stated that he received the flu shot in October 2014 and "the pain seemed to start after that." *Id.* Petitioner again stated that the area where he received the injection was "raised and swollen for awhile." *Id.* Now, the pain radiates down to his elbow and at times petitioner was experiencing numbness in his hands. *Id.* The six-day Medrol pack did not provide any symptom relief. *Id.* He next saw Dr. Russell Huffman at Penn Orthopedics who performed an exam of petitioner's left shoulder. Petitioner had a positive impingement sign, tenderness over the deltoid area, and "restricted internal rotation with the left thumb going only to the sacrum." *Id.* Dr. Huffman stated that there were no cervical radicular findings. *Id.* Dr. Huffman diagnosed petitioner with "left rotator cuff tendinitis," and that he was concerned about petitioner developing adhesive capsulitis. *Id.* He ordered petitioner to physical therapy.

Petitioner presented to his first physical therapy appointment on March 23, 2015. Pet. Ex. 3 at 11. It was noted that petitioner was referred to physical therapy "secondary to left shoulder pain, stiffness, and swelling after getting a flu shot on 10/22/2014." *Id.* Petitioner reported that his pain was an 8 out of 10 at best and 9/10 at worst. *Id.* Petitioner demonstrated decreased range of motion compared to his right shoulder in all planes of movement. *Id.* He also had tenderness throughout his left subacromial area, especially over the biceps long head and supraspinatus tendons. *Id.*

On April 7, 2015, petitioner underwent a left shoulder MRI at Einstein Medical Center. Pet. Ex. 3 at 10. The MRI revealed partial-thickness tears of the supraspinatus, infraspinatus, and subscapularis tendons; a subacromial subdeltoid bursitis; and mild scarring of the rotator interval with thickening of the coracohumeral ligament, consistent with subacute or chronic adhesive capsulitis. *Id.*

Petitioner had an appointment with Dr. Huffman on May 28, 2015. Pet. Ex. 6 at 29. Dr. Huffman wrote that petitioner received "an influenza injection.…by a nurse practitioner. This is fairly standard, although it may have been a little high in the anterior deltoid." *Id.* He continued, writing that petitioner started "having pain and swelling, inflammation, and a sensation of heat," that night. *Id.* Petitioner's physical exam revealed that he had "zero degrees of external rotation, compared to 45 degrees on the contralateral side," and "70 degrees of abduction compared to 90." *Id.* Additionally, petitioner had limited glenohumeral abduction and his "arc of range of motion on the left side," was 30 degrees compared to 125 degrees on the right side. *Id.* Dr. Huffman noted that petitioner had some fluid in the subacromial bursa, capsular thickening in the axillary recess which was consistent with adhesive capsulitis, and some AC joint arthrosis. *Id.* Dr. Huffman assessed petitioner with, "idiopathic adhesive capsulitis with onset temporally and most likely causally related to the influenza injection." *Id.* Dr. Huffman wrote that petitioner was "heading off an inflammatory cascade," and he administered a corticosteroid injection to the petitioner. *Id.* at 30.

Petitioner returned to Dr. Huffman on June 23, 2015 for "left shoulder pain." Pet. Ex. 6 at 32. It was noted that petitioner received a cortisone injection three weeks ago and it was "ineffective." *Id*. Dr. Huffman wrote that petitioner "had an influenza vaccine given high in the deltoid region about 8 to 9 months ago. He has had persistent pain and symptoms since that time. He has reactive capsulitis consistent with adhesive capsulitis. He also has AC joint arthrosis." *Id*. at 38. Dr. Huffman wrote that petitioner was "tired of conservative treatment," and that the corticosteroid injection did not provide any symptoms relief. *Id*. Dr. Huffman wrote that the plan was for petitioner have a debridement and possible capsular release on July 15, 2015. *Id*.

On July 15, 2015, petitioner underwent an arthroscopic surgery of his left shoulder. Pet. Ex. 6 at 39. His pre-operative diagnosis was, "rotator cuff tear; acromioclavicular joint arthritis; adhesive capsulitis; and rotator cuff impingement." *Id*. He had a rotator cuff repair, distal clavicle excision, capsular release, and subacromial decompression. *Id*.

On August 18, 2015, petitioner underwent an EMG/NCS. Pet. Ex. 23 at 12. Petitioner was being evaluated for "pain and numbness in his left upper extremity." *Id*. It was recorded that petitioner had "pain that originates in the left anterior shoulder and radiates down the arm to the forearm." *Id*. Petitioner reported intermittent numbness in all of the fingers of the left hand. *Id*. Dr. Shawn Bird, the Chief of the Neuromuscular Division at the University of Pennsylvania Hospital, performed a physical exam which showed that petitioner had absent reflex in his left biceps and demonstrated weakness in the triceps of the left arm. *Id*. The NCS found that petitioner's left median sensory responses were slowed across the wrist and the left median-to-ulnar comparison studies across the wrist were abnormal. *Id*. Additionally, petitioner's left lateral antebrachial cutaneous sensory response was absent. *Id*. The EMG revealed evidence of "severe chronic denervation in the left biceps muscle," and there was evidence of "mild, chronic denervation in the abductor pollicis brevis muscle." *Id*. The impression of EMG/NCS was, "severe, chronic left musculocutaneous neuropathy and mild-to-moderate, left median neuropathy at the wrist (carpal tunnel syndrome). *Id*.

Petitioner returned to Dr. Huffman on September 1, 2015. Pet. Ex. 6 at 8. Dr. Huffman explained "because of the neurogenic nature of [petitioner's] pain, we ordered an EMG which was done by Dr. Shawn Bird that shows that he has a musculocutaneous nerve subacute or chronic injury, which is, according to Dr. Bird, six or more months old." *Id*. Petitioner had atrophy of the biceps noted in the physical exam. *Id*. Additionally, petitioner had dysesthesia and some signs of complex regional pain in the left upper extremity, which Dr. Huffman opined were "consistent with a nerve injury." *Id*. Dr. Huffman recommended that petitioner see Dr. Eric Zager, a Penn neurologist, "who specializes in brachial plexus nerve injuries and treatment." *Id*. Dr. Huffman also wrote, "The surgery I did about a month ago, and I do not think it has any relation to the nerve issues which are contributing overall to his arm pain and shoulder dysfunction." *Id*.

On October 21, 2015, petitioner had an appointment with neurologist, Dr. Eric Zager. Pet. Ex. 23 at 11. Under History of Present Illness, Dr. Zager wrote that petitioner had a flu shot on October 22, 2015 and "within a day of getting the injection [petitioner] complained of left shoulder pain and swelling. His pain was so severe with movement he ultimately had a frozen

shoulder. He consulted with ortho and had arthroscopic left shoulder surgery with Dr. Huffman in July 2015. He did not recover well and feels his pain is now even worse." *Id*. Petitioner reported left shoulder and upper arm pain, hypersensitivity, and limited range of motion in his entire arm. *Id*. On physical exam Dr. Zager noted normal strength in the right upper extremity but 4/5 in the left deltoid, triceps, biceps, wrist extensors, wrist flexors, hand grip and 3/5 on finger extensors. He also observed mild scapular winging, reduced range of motion in the left shoulder, normal cervical range of motion, atrophy of the left biceps and reduced sensation in the left upper extremity. Ex 13 at 625 Dr. Zager reviewed petitioner's EMG/NCS and MRIs and diagnosed petitioner with a primary diagnosis of Parsonage-Turner Syndrome. *Id*. He also diagnosed petitioner with mild carpal tunnel syndrome of the left wrist. *Id*.

Petitioner had a follow-up appointment on October 27, 2015, with Dr. Huffman. Pet. Ex. 18 at 51. Dr. Huffman wrote that petitioner has severe pain and muscle atrophy in the musculocutaneous nerve distribution of his left upper extremity and "diffuse pain and dysfunction consistent with Complex Regional Pain Syndrome." *Id*. Petitioner had 10 degrees of external rotation and abduction to 60 degrees of his left shoulder. *Id*. Additionally, Dr. Huffman noted that petitioner had "profound atrophy in the biceps, periscapular musculature and upper arm." *Id*. Dr. Huffman referred petitioner to Dr. Larry Chou for pain management for the neurogenic pain. *Id*.

Petitioner had an appointment with Dr. Huffman on December 15, 2015. Pet. Ex. 18 at 57. At this appointment, Dr. Huffman wrote, "[Petitioner] had an influenza vaccine in his left deltoid last October. He developed adhesive capsulitis and neurogenic sequelae. He continues to recover from that." *Id*. Dr. Huffman encouraged petitioner see Dr. Chou for the neuropathic pain. *Id*.

Petitioner saw Dr. Huffman again on March 8, 2016. Pet. Ex. 18 at 63. At this appointment, Dr. Huffman observed that petitioner had discoloration in his left arm and hand "with obvious temperature changes with coolness and pallor even with a palpable radial pulse." *Id*. Additionally, Dr. Huffman wrote, "it is clear that he has some autonomous nervous dysregulation in the left upper extremity." *Id*. He ordered a repeat EMG/NCS. *Id*.

On October 4, 2016, petitioner had an appointment with Dr. Russell Huffman. Pet. Ex. 18 at 73. Dr. Huffman wrote, "…this 62-year-old gentleman had an adverse reaction to an influenza vaccination. He developed adhesive capsulitis, Parsonage-Turner Syndrome, and also musculocutaneous nerve involvement injury. He ultimately went on to develop adhesive capsulitis today and had a contracture release." *Id*. Petitioner had a repeat EMG. Dr. Huffman saw petitioner on October 25, 2016 and wrote, "I had him get a new EMG as I saw small bit of biceps recovery. The EMG confirms that he has some reinnervation of the musculocutaneous nerve, although there is no real conduction across the lateral antebrachial cutaneous nerve. *Id*. at 77.

Petitioner returned to Dr. Huffman on April 4, 2017. Pet. Ex. 18 at 82. Dr. Huffman noted that petitioner had "most of his shoulder motion back, but his pain, numbness, tingling and dysesthesias have not improved." *Id*. The physical exam showed petitioner had "pain with active forward elevation, active abduction, but has good passive external rotation and passive

abduction." *Id.* Dr. Huffman wrote, "I suspect that he will live with this permanently." *Id.* at 83.

On August 8, 2017, petitioner saw Dr. Huffman for a follow-up appointment. Pet. Ex. 18 at 89. Dr. Huffman again reiterated that petitioner received an influenza vaccine and developed "adhesive capsulitis as well as a brachial plexopathy and Parsonage Turner Syndrome." *Id.* Dr. Huffman observed that petitioner had "return of motion, but his [petitioner's] pain and neurologic deficits have persisted." *Id.* Dr. Huffman stated that petitioner still had weakness in the musculocutaneous nerve distribution and that petitioner's "biceps is firing, it is certainly asymmetric compared with the contralateral side." *Id.*

On April 16, 2019, Dr. Huffman recommended that petitioner have a repeat MRI of his left shoulder and a repeat EMG. *Id.* at 101-02. Petitioner had a repeat EMG/NCS on May 14, 2019. Pet. Ex. 22 at 6. When petitioner presented for his EMG study, the "History," explained that petitioner's October 2016 study "demonstrated a musculocutaneous neuropathy on the left with significant reinnervation of the left biceps muscle and mild left carpal tunnel syndrome." *Id.* Petitioner reported that he was having increased pain in his left arm with use and felt as if his arm was "heavy" and "weaker." *Id.* The NCS demonstrated that petitioner had absent sensory response in the left lateral antebrachial cutaneous and the "left median motor responses were notable for a prolonged distal latency." *Id.* Additionally, the needle EMG showed evidence of "mild, chronic denervation in the left biceps and APB muscles." *Id.* The impression was, "There was good re-innervation of the biceps muscle with only mild, chronic denervation. This finding will always be present as the sequela of the prior musculocutaneous nerve injury." *Id.*

b. Petitioner's Expert Reports

1. Dr. Russell Huffman

On December 19, 2016, petitioner filed an expert report from his treating orthopedist, Dr. Huffman. Pet. Ex. 8 (ECF No. 24). Dr. Huffman stated that it was his opinion that petitioner's "symptoms and injury are directly and causally related to the vaccination he received on 10/22/2014." *Id.* at 1.

Dr. Huffman wrote that petitioner had "no prior history of left arm or shoulder symptoms," and on the "same day of his influenza vaccination, he experienced acute pain and swelling in his left shoulder." *Id.* at 3. He continued, stating, "In the aftermath of his initial symptoms, [petitioner] developed a brachial plexus neuropathy (Parsonage Turner syndrome) in the musculocutaneous nerve and adhesive capsulitis." *Id.*

Dr. Huffman explained that Parsonage Turner Syndrome and adhesive capsulitis are "independently associated with adverse vaccination reactions." Pet. Ex. 8. Dr. Huffman stated that, "adhesive capsulitis is independently associated with Parsonage Turner syndrome, which itself requires a viral prodromal syndrome or an inflammatory nidus such as a vaccination." *Id.* In reviewing petitioner's history, Dr. Huffman noted petitioner's left shoulder pain was documented as occurring shortly after the vaccination leading to limited range of motion in the left arm and shoulder. But it was not until March of 2015 that the concern for adhesive capsulitis

arose. By the time he was seen by Dr. Huffman, petitioner was suffering from both Parsonage Turner syndrome and adhesive capsulitis. *Id.* at 2.

He opined, "[Petitioner's diagnoses of neuropathy and adhesive capsulitis both fit the epidemiologic criteria for causality: temporal association (…immediate onset after the vaccination); consistency and plausibility (the literature is clear on the association of vaccination associated brachial neuropathy including of the musculocutaneous nerve and adhesive capsulitis independently and in association with one another); and specificity (there is no other explanation for his development of Parsonage Turner syndrome). *Id.*

2. Dr. Vera Byers

Petitioner submitted two expert reports from immunologist, Dr. Vera Byers. Pet. Exs. 9 and 10. After reviewing petitioner's medical history, Dr. Byers observed that petitioner first underwent a capsular release and rotator cuff repair, which did not relieve petitioner's pain. Pet. Ex. 9 at 6. She also agreed with Dr. Huffman that petitioner had Parsonage Turner syndrome and that it was more likely than not, caused by the October 22, 2014 flu vaccine. *Id.* Dr. Byers stated that petitioner's torn rotator cuff "could have been present before the vaccination and just exacerbated by the inflammation." *Id.* Dr. Byers stated that "a few days after the vaccination, petitioner presented with a "lump' at the injection site." *Id.* She stated that "the "lump" indicates induration or infiltration at the site of macrophages/dendritic cells and T cells. The macrophages/dendritic cells would be producing proinflammatory cytokines which call in more macrophages as well as the antigen specific memory T cells, which would have been present secondary to his many prior flu shots." *Id.* She further stated that "antibody producing B cells would have been activated. The macrophages would begin producing cytokines such as TNF-α within a few hours, and the T and B cells would be activated within a few days. I believe that this was the cause of his adhesive capsulitis." *Id.*

Dr. Byers explained that Parsonage Turner syndrome ("PTS") or idiopathic brachial plexopathy consists of a syndrome characterized by the abrupt onset of unilateral shoulder pain. *Id.* at 3. Dr. Byers stated that Parsonage Tuner Syndrome "is usually an autoimmune reaction triggered by a viral infection or the viral antigen in the immunization." Pet. Ex. 9 at 3. She explained that it can occur post-surgery and "it is assumed that [PTS] is either caused by the positioning of the body such that the brachial plexus becomes traumatically stretched, or trauma associated with needles of the anesthetist entering the shoulder bursa." *Id.* She stated that involvement of the musculocutaneous nerve, that was damaged in this case, is not common, but reported in medical literature. *Id.* She cited to a case report by *Besleaga et al.*, which described musculocutaneous neuropathy cases. Pet. Ex. 9, Tab 1. The authors explained that the musculocutaneous nerve arises from the lateral cord of the brachial plexus and contains fibers from the C5, C6, and C7 spinal nerve roots….The musculocutaneous nerve passes through the coracobrachialis muscle and descends between the biceps brachii and brachialis muscles which it innervates. *Id.* The authors noted that "the musculocutaneous anterior interosseous, ulnar, and median nerves" have also been occasionally involved in Parsonage Turner syndrome, which "is a rare disorder of unknown etiology, usually presenting with pain and weakness of the shoulder and upper extremity." *Id.* at 3. The authors stated that, "The exact etiology of the disorder is not

fully understood, but 25% of cases occur after a viral infection, and 15% occur after immunization." *Id.* at 4.

Then Dr. Byers explained that intradermal vaccines are "more potent than the usual subcutaneous or intramuscular administration." Pet. Ex. 9 at 4. She stated that the intradermal administration for influenza vaccines is very important in generating immune responses for older adults. *Id.* She cited to an article by *Hung et al.*, which measured influenza antibodies titers in elderly and chronically ill adults to determine whether the intradermal vaccine would have the same immunogenicity compared to the intramuscular flu vaccines. Pet. Ex. 9, Tab 7.[8] Dr. Byers noted that the authors found that antibody titers were significantly higher in the low dose intradermal patients than in the full dose intramuscular patients. Pet. Ex. 9 at 4. She stated that these findings were consistent with the findings of the *Tsang et al.*, article which tested the immunogenicity and safety of the Fluzone intradermal and high-dose flu vaccines in older adults. *Id.*; Pet. Ex. 9, Tab 13.[9] The authors found that the individuals who were administered the intradermal flu vaccine had "post-vaccination geometric mean titers induced by the ID vaccines that were superior to those induced by standard-dose intramuscular vaccines." Pet. Ex. 9, Tab 13 at 1. The authors explained, "Intradermal vaccines exploit the numerous antigen-presenting dendritic cells, macrophages, and T cells present in the skin as well as its dense network of lymphatic and blood vessels. These features enable strong innate and adaptive immune responses to be generated following intradermal exposure to vaccine antigens." *Id.* at 2. Interestingly, the study found that injection site swelling, injection site pruritus, injection site pain, and injection site induration was higher in patients who received the intradermal vaccine compared to those who received an intramuscular vaccination. *Id.*

Dr. Byers explained the lump that petitioner experienced at the vaccine injection site was caused by the "whole area being flooded with cytokines." Pet. Ex. 9 at 4. She explained that the dermis has a dense network of immune stimulatory antigen-presenting cells (dendritic cells/macrophages) and "it is also rich in micro vascular systems that enable interaction between the cells of the immune system and the network of the regional lymph node." *Id.* Further, the intradermal administration of antigen improves the recruitment of the dendritic cells, which pick up the foreign antigen, such as the vaccine, and then mature to produce pro-inflammatory cytokines, mainly IL-1β and TNF-α. These promote the migration of the dendritic cells to the para-cortical area of the regional lymph nodes, which allows the dendritic cells to present the vaccine peptides to CD8+ T cells and CD4+ lymphocytes. *Id.*

While Dr. Byers presented two mechanisms of injury from the intradermal flu vaccine. Pet. Ex. 9 at 5. The first mechanism is the "antigen-antibody complexes hanging up in the vessels serving the musculocutaneous nerve. These complexes fix complement, thereby serving as an inflammatory nidus which damage the underlying nerves." *Id.* The other theory she proposed was that the intradermal vaccine triggered the dendritic cells in the dermis, which then induces the "the secretion of pro-inflammatory cytokines such as TNF-α….causing tissue

[8] Hung, IF et al., *Dose sparing intradermal trivalent influenza (2010/2011) vaccination overcomes reduced immunogenicity of the 2009 H1N1 strain,* 45 Vaccine 6427-35 (2012). [Pet. Ex. 9 Tab 7].

[9] Tsang, Peter, et al., *Immunogencity and safety of Fluzone intradermal and high-dose influenza vaccines in older adults ≥ 65 years of age: A randomized, controlled phase III trial,* 32 Vaccine 2507-2517 (2014). [Pet. Ex. 9, Tab 13].

damage, and inducing cytokines by astrocytes and micoglia within the nerve itself." Pet. Ex. 9 at 5. She continued, stating, "These dendritic cells respond with hours of antigen presentation, with secretion of the cytokines, which can rapidly flood the area with inflammatory cells." *Id*. She explained, "Because of the temporal relationship I believe this…explanation is the most logical." *Id*.

Dr. Byers wrote that the temporal association between the vaccination and onset of petitioner's was "very rapid…as immediate to a day." Pet. Ex. 9 at 7. She stated that, "Activation of dendritic cells and production of cytokines begins within hours of vaccination." *Id*.

In her second report, Dr. Byers responded to Dr. Rose, respondent's expert's opinion that there is "no epidemiologic basis for assigning a cause-and-effect association between Fluzone intradermal influenza vaccine and PTS." Pet. Ex. 10; *see also* Resp. Ex. 1 at 9. Dr. Byers stated acknowledged that there are "no epidemiologic studies associating" the flu vaccine with brachial neuritis, however, she noted that PTS is a "rare disorder" in which epidemiologic study would be "almost impossible." Pet. Ex. 10 at 2. Dr. Byers noted that Dr. Rose referenced an article by *van Alfen,* which reviewed the clinical and pathophysiological concepts of PTS, and stated the "neurologic community agrees [that] this disease has an autoimmune etiology." Pet. Ex. 10 at 2. The *van Alfen* article explained that "greater than 50% of patients with [PTS] report an immune event before an attack led to the hypothesis that attacks are immunologically precipitated…..Associations with different types of immunological events (for example, infection, vaccination, surgery, pregnancy, childbirth, and immunotherapy) have been reported…Overall, [PTS] is thought to be of autoimmune origin…." Resp. Ex. 1, Tab 2.[10] Dr. Byers stated that treatment for PTS has focused on "blocking proinflammatory cytokines," and the treatment involves "relatively nonspecific anti-inflammatory agents, such as steroids." Pet. Ex. 10 at 1.

Dr. Byers stated that it was her opinion that cytokines, which were initiated as the immune reaction to the vaccine, caused neurologic damage. Pet. Ex. 10 at 1-2. She stated that, the fact that "the most common side effect of vaccinations are injection site reactions caused by the local effect of pro-inflammatory cytokines," demonstrates that a "cytokine storm" could easily affect the local area of the vaccination and damage the nerves, thus causing PTS. *Id*. at 2. She stated, "The temporal association along with the absence of confounding factors leads to my opinion, to a reasonable degree of medical certainty that [petitioner's] PTS was caused by…the vaccination he received on October 22, 2014." *Id*. at 2.

3. Dr. Maria Fangchun Chen's opinion on vaccine causation

Petitioner submitted two reports from Dr. Maria Chen, responding to respondent's experts' opinions. Pet. Ex. 19 & 25. In her first report, Dr. Chen explains that "PTS or neuralgic amyotrophy is a rare condition of an injury to the brachial plexus. Its incidence is cited at approximately 2-3 cases per 100,000, although this is likely an under-estimation with likely cases being misdiagnosed as musculoskeletal disorders of the shoulder or cervical

[10] Van Alfen, Nens *Clinical and Pathophysiological Concepts of Neuralgic Amyotrophy,* 7(6) Nature Reviews Neurol. 315-322 (2011). [Resp. Ex. 1, Tab 1; Pet. Ex. 20, Tab D].

radiculopathies." Pet. Ex. 19 at 2. She stated that the causes of PTS are not fully known, but "when a proximal trigger is identified, the most common trigger are either due to post-viral syndrome or post-immunization." *Id.* Dr. Chen opined that the intradermal flu vaccine petitioner received caused his Parsonage Turner syndrome. *Id.* at 5.

Dr. Chen also cited to the *Van Alfen* article, which found that, "The initial nerve trunk pain and signs of peripheral nervous system inflammation, which shows up as brachial plexus hyperintensity on acute-phase T2 weighted MRI scans, are thought to be additional arguments for an immune process." Pet. Ex. 20, Tab D at 6. The article explained, "Peripheral sensory nerve biopsy samples from patients with subacute neuralgic amyotrophy showed epineural perivascular T-cell infiltrates and CD20+ B lymphocyte germinal centers around a dorsal ganglion." *Id.* Further, the article observed that the "T-lymphocyte subsets during the acute phase of neuralgic amyotrophy reported a decrease of CD8+T suppressor cytotoxic lymphocytes" were also seen in other "autoimmune PNS disorders such as Guillain-Barre syndrome and recurrent Bell's palsy." *Id.*

Dr. Chen wrote that "the inflammatory nature of [PTS] has been recognized since biopsies of nerves demonstrate inflammatory cells such as T cell infiltrate and macrophages, present in the blood vessel walls supplying the injured nerve, which is a vasculitic process." *Id.* Dr. Chen referenced an article by *Collins* and *Hadden*, which examined various nonsystemic vasculitic neuropathies, including brachial plexus-neuropathy. Pet. Ex. 20, Tab C.[11] The article explained that brachial plexus-neuropathy effects motor nerves, especially those derived from the upper plexus, and that "almost all patients experience acute, severe, continuous pain," that can last a median of 20 days." *Id.* at 6. Then patients develop weakness within 1-2 weeks following the pain. *Id.* The article reviewed other literature that examined nerve biopsies from patients with brachial plexus-neuropathy and opined, "On the basis of [the] histopathological evidence and the clinical phenotype of acute, painful, axonal, multifocal sensorimotor neuropathy, neuralgic amyotrophy might represent a self-limited variant of [non-systemic vasculitic neuropathy]." *Id.*; Pet. Ex. 19 at 3.

Dr. Chen explained that "Vasculitic-based injuries can be sudden and immediate, within hours of the insult, as the inflammatory mediators in a vasculitic immune response initially involve chemokines, cytokines, complement, and immune cells of the innate immune system (dendritic cells, macrophages, natural killer cells) that do not need a prior memory to respond." Pet. Ex. 19 at 3. Citing to the Sanofi-Pasteur Fluzone package insert, Dr. Chen states that "the intradermal vaccination is effective because the application of the antigen into the skin generates this robust innate immune response via mechanisms that are not present in an intramuscular application." *Id.* at 3. Dr. Chen stated:

> First, skin harbors higher levels of antigen presenting cells that are necessary primary players in presenting the viral antigen to components of the memory immune response. Second, vaccine antigen and other small components are drained from the skin by "unique microvascular and lymphatic structures of the skin to draining lymph nodes

[11] Collins, Michael P, & Hadden, Robert, *The nonsystemic vasculitic neuropathies*, 13 Nature Neurol. Review, 302-317 (2017). [Pet. Ex. 20, Tab C].

> where even more antigen presenting cells (dendritic cells and macrophages) reside. Thirdly, the local skin injury generates molecular signals that cause inflammatory cascades via damage associate molecular signals that reside in the skin.

Id. at 3. Dr. Chen stated that "this inflammatory cascade results in a local inflammatory response," as marked by "higher levels of injection site reaction." *Id.* Dr. Chen observed that the package insert demonstrated that the Fluzone intradermal had higher reports of injection-site erythema, induration, and swelling compared to the intramuscular vaccination. *Id.*; *see also* Resp. Ex. C, Tab 8 at 10.[12] Specifically, the package insert explained that 76.4% of intradermal Fluzone recipients had injection-site erythema compared to 13.2% of intramuscular flu recipients and 56.4% of intradermal Fluzone recipients complained of injection-site swelling compared to 8.4% of intramuscular flu recipients. Resp. Ex. C, Tab 8 at 10. According to Dr. Chen, the increased rates of injection-site reactions for the intradermal vaccine compared to the intramuscular flu vaccine demonstrates that the "heightened innate immune response is a local immune response which contributes to the development of a local vasculitic process in the same arm in which the vaccine was administered." Pet. Ex. 19 at 3. Dr. Chen also observed that the package insert listed "brachial neuritis" as a "Nervous System Disorder" that was reported as an adverse event in the post-approval use of the Fluzone intradermal vaccine. *Id.*; *see also* Pet. Ex. 20, Tab M at 10.

Dr. Chen also addressed Dr. Callaghan's opinion that petitioner's "severe, uncontrolled diabetes," could have been the cause of petitioner's shoulder issues, including the brachial neuritis. Pet. Ex. 19 at 4; Resp. Ex. A at 3-4. Dr. Chen argued that the *Massie et al.* article does not demonstrate diabetes as a causal mechanism for brachial neuritis, but instead it describes "the characteristics of brachial neuritis *when* brachial neuritis occurs in patients who have diabetes." Pet. Ex. 19 at 4; citing Resp. Ex. A, Tab 1 & Pet. Ex. 26.[13] She stated that the *Massie* article "specifically selected patients who had diabetes in order to further examine diabetic patients with Parsonage Turner." *Id.* She stated, "…the *Massie* study does nothing to clarify the picture of Parsonage Turner when it occurs in diabetic patients v. nondiabetic patients." *Id.* at 4. She wrote that the "The main unique points of the *Massie* study was to report on MRI brachial plexus findings and autonomic studies that seem to be predominant in diabetes. Notably the classic finding of "increase[d] nerve T2 signal" in the brachial plexus found in 45 of 47 patients was not seen in [petitioner]." *Id.* Then Dr. Chen observed that the *Massie* study also confirmed that brachial neuritis has a wide variety of causes, including vaccinations. Pet. Ex. 19 at 4. The study stated:

> We speculate that diabetes mellitus is one of perhaps several risk factors that *predisposes* patients to altered immunity leading to an auto-immune attack on the nerve small blood vessels…..The various positive inflammatory and rheumatological markers are also consistent with an alteration in the immune system. The majority of patients (49/85)

[12] Package Insert Highlights: Fluzone Intradermal Quadrivalent (Influenza Vaccine); Suspension for Intradermal Injection (2017). [Resp. Ex. C, Tab 8; Pet. Ex. 20, Tab M].

[13] Massie, R. et al., *Diabetic cervical radiculoplexus neuropathy: a distinct syndrome expanding the spectrum of diabetic radiculoplexus neuropathies,* 135 Brain 3074-3088 (2012). [Resp. Ex. A, Tab 1; Pet. Ex. 26]

> reported a potential immune trigger (10 post-viral/systemic illness, three post-vaccination, 26 post-surgical procedures, and nine after minor trauma or heavy exercise.

Resp. Ex. A, Tab 1 at 14; Pet. Ex. 26 at 14.

Dr. Chen acknowledged that petitioner had uncontrolled diabetes up to two years prior to the flu vaccination, but that he had not developed any neurological complications of diabetes. Pet. Ex. 19 at 5. She stated, "It was not until the application of the Fluzone…on 10/22/2014 that [petitioner] developed left arm pain and weakness. The flu vaccine was the only preceding factor, and the only immune-based trigger prior to the onset of [petitioner's] symptoms which has been identified as Parsonage-Turner." *Id.*

Responding to Dr. Callaghan and Dr. Tompkins supplemental reports, which continued to assert that the cause of petitioner's left arm pain and weakness was his uncontrolled diabetes, she stated that "the clinical presentation and attributes of [petitioner's] neuropathy is not consistent with a diabetic amyotrophy. Pet. Ex. 25 at 1. She observed that Dr. Callaghan "admits that the presentation of diabetic radiculoplexus neuropathy is less common in the arm and more commonly occurs in the legs." *Id.* at 1; *see* Resp. Ex. E at 1 (opining that "petitioner suffered from a diabetic cervical radiculoplexus neuropathy."). Dr. Chen states, "The prominent associated feature that is seen with diabetic radiculoplexus neuropathy in many publications, including Dr. Callaghan's own publication, is the presence of weight loss (typically 15-30 lbs) coinciding with the development of neuropathy. Pet. Ex. 25 at 1. She observed that petitioner did not experience "any weight loss as evidenced" by the medical records. *Id.* Dr. Chen also argued that "there is also often involvement of other body regions as evidence of a systemic disease such as diabetes to be causal of the neuropathy," but that petitioner's physical examinations and EMG did not show any evidence of further neuropathy in other body parts. *Id.* at 2. She again referenced the *Massie* article, which explained that with diabetic lumbosacral radiculoplexus neuropathy (DLPRN) "onset was predominately unilateral with subsequent spread to the contralateral side in many," and that "Involvement of other regions of the Peripheral Nervous System was common in DLRPN…Thirty patients experienced concomitant contralateral cervical disease, while 16 had thoracic radiculopathy…" Resp. Ex. A, Tab 1 at 4; Pet. Ex. 26 at 4. Dr. Chen wrote that "[petitioner's] neuropathy is limited to his left arm which is unlike a DLPRN," and that "The clinical presentation of [petitioner's] neuropathy does not have common features expected from a diabetic radiculoplexus neuropathy. The mere presence of diabetes is not sufficient to make this diagnosis." Pet. Ex. 25 at 2.

Dr. Chen then addressed Dr. Tompkins' opinion that petitioner's brachial neuritis was "more commonly attributed to diabetes than to immunological causes." Pet. Ex. 25 at 2. She observes that Dr. Tompkins cites to the *van Alfen* article, which "demonstrates that brachial neuritis is more commonly seen after precipitating events that generate immune response than with diabetes." *Id.* She stated that the *van Alfen* article identifies 246 cases of brachial neuritis and that 4.3% of cases reported vaccination as the antecedent event, but none of the cases of brachial neuritis were "attributed to diabetes." *Id.*; *see also* Resp. Ex. C, Tab 3.[14] The *van Alfen*

[14] *van Alfen, N. & van Engelen, B.*, The clinical spectrum of neuralgic amyotrophy in 246 cases, 129 Brain 438-450 (2006). [Resp. Ex. C, Tab 3].

article explained that 53.2% of patients reported an antecedent event before onset of pain. Resp. Ex. C, Tab 3 at 6. Fifty patients reported an infection prior to the onset of the brachial neuritis and five patients reported a vaccination as the antecedent event. *Id.* Dr. Chen observed that petitioner did not have any infectious event prior to the onset of his symptoms. Pet. Ex. 25 at 2.

Finally, Dr. Chen observed that Dr. Tompkins' assertion that the "intradermal vaccine does not elicit a greater innate or adaptive immune responses than the intramuscular vaccine, and therefore it cannot cause brachial neuritis," is inconsistent with some of the medical literature he cited that shows evidence "that the intradermal Fluzone vaccine provides systemic immune responses that are equivalent to the intramuscular flu vaccine, which notably have been attributed to post-vaccine neurological adverse events, including brachial neuritis." Pet. Ex. 25 at 2. Dr. Chen asserts that Dr. Tompkin's opinion that "there is no evidence to demonstrate the role of innate immune response in causation of brachial neuritis," and his reliance on *Suarez* to support his opinion is flawed. *Id.* She states that, "This use of *Suarez* is flawed as the timing of the biopsies was well past the acute phase of the disease. Even if an innate immune response had been present, it cannot be detected if one waits until the response has abated to sample the tissue in the chronic phase." *Id.* at 2. The *Suarez et al.* article that Drs. Tompkins and Chen referenced, examined biopsies from four patients with brachial plexus neuropathy. Pet. Ex. 38.[15] The authors of this article wrote, "Although there is some information about the natural history and frequency of this disorder (brachial plexus neuropathy), little is known about its cause or pathogenesis. The clinical course and the reported association with viral infection, immunization, interferon and interleukin-2 (IL-2) theory, and serum sickness suggest an inflammatory-immune mechanism." *Id.* at 1. The authors found "conspicuous mononuclear inflammatory infiltrates…surrounding epineural and endoneurial vessels." *Id.* Dr. Tompkins interpreted the findings of *Suarez* to mean that "the observed infiltrates were predominantly T and B cells, suggesting an adaptive immune response contributed to neuronal disease, rather than the innate response proposed by Dr. Chen." Resp. Ex. C at 4. In response, Dr. Chen states, "To show definitive evidence that an innate immune response is present in the affected nerve is practically impossible as we neurologists do not sample nerves acutely without empiric treatment first, given the consequences of nerve sampling will most likely result in a neurological deficit that is permanent and likely avoidable." Pet. Ex. 25 at 2.

Dr. Chen also agreed with Dr. Tompkins that the intradermal flu vaccine may elicit a greater innate immune response compared to intramuscular vaccines because the "innate antigen presenting cells (in the skin) are better activated and those cells and the vaccine antigen are more efficiently delivered to lymph nodes, activating the adaptive response." Pet. Ex. 25 at 6; *see also* Resp. Ex. C at 6. Dr. Chen stated that, "Dr. Tompkins points out that more efficient antigen presenting cells are delivered to the lymph nodes to activate the adaptive response that would then occur in the lymph nodes. Notably, the draining lymph nodes of the arm are in the axilla of the arm, which also houses nerves of the brachial plexus." Pet. Ex. 25 at 3. In her opinion, "an enhanced immune response from the lymph nodes in the axilla is what injured the nerves of the brachial plexus that also reside in the axilla. The timing of the onset of symptoms (3 days from the vaccine) together with the mechanism that Dr. Tompkins provides, [offers] support for the intradermal Fluzone vaccine to be the cause of [petitioner's] brachial neuritis." *Id.*

[15] *Suarez, G.A., et al.*, Immune brachial plexus neuropathy: Suggestive evidence for an inflammatory immune pathogenesis, 46 Neurol. 559-561 (1996). [Pet. Ex. 38].

Dr. Chen concluded her report stating that, "Dr. Callaghan does not provide sufficient evidence that [petitioner's] neuropathy stemmed from his diabetes and the clinical presentation is not aligned with the alternative diagnosis presented by Dr. Callaghan." Pet. Ex. 25 at 3. She also stated that "Similarly, Dr. Tompkins's proposals of alternative diagnosis are equally flawed. Notably, Dr. Tompkins highlights an aspect of the intradermal flu vaccination that supports the causation of the vaccination with [petitioner's] brachial neuritis." *Id*. It is her opinion that the intradermal flu vaccine petitioner received on October 22, 2014 was the cause of his left arm brachial neuritis. *Id*.

c. Respondent's Experts Reports

1. Dr. Brian Callaghan's opinion on vaccine causation

Respondent submitted three expert reports from neurologist, Dr. Brian Callaghan. Resp. Exs. A, E, & F. After reviewing petitioner's medical records and the reports written by Drs. Byers, Huffman, and Chen he disagreed with their opinions that "the evidence supports vaccination as the most likely cause of [petitioner's] adhesive capsulitis and neuropathy." Resp. Ex. A at 3. He states, "The timing of symptoms in relation to the vaccine is inconsistently reported with reports of pain pre-dating his vaccination." *Id*. Additionally, Dr. Callaghan opined that petitioner did not have brachial neuritis, but "adhesive capsulitis and cervical radiculoplexopathy" which was caused by petitioner's underlying diabetes. Resp. Ex. E at 3; Resp. Ex. F at 1-2.

Dr. Callaghan argued that left shoulder pain petitioner experienced was more likely caused by "severe uncontrolled diabetes." Resp. Ex. A at 3. It was his opinion that petitioner had "diabetic cervical radiculoplexus neuropathy given the longstanding and uncontrolled diabetes." Resp. Ex. E at 1. He stated that, "Diabetic cervical radiculoplexus neuropathy is very similar to brachial neuritis, but the trigger is secondary to diabetes." *Id*. He stated, "In both conditions, patients have severe shoulder pain followed by weakness followed by recovery. In both conditions, a mononeuropathy such as musculocutaneous mononeuropathy can develop." *Id*. Dr. Callaghan wrote, "The evidence for diabetes being linked to this condition far outweighs the evidence for vaccinations being linked to brachial neuritis." *Id*. In his second report, he stated that the clinical conditions of diabetic lumbosacral radiculplexus neuropathy and diabetic cervical radiculoplexus neuropathy "share similar symptoms, signs, and underlying pathology, including microvasculitis on nerve biopsy." Resp. Ex. E at 1. Dr. Callaghan wrote, "…diabetic lumbosacral radiculoplexus neuropathy, which is almost identical to diabetic cervical radiculoplexus neuropathy, except that it affects the nerve plexus in the leg instead of the arm, is well established as being caused by diabetes." *Id*. at 1. He referenced an article by *Dyck et al,* which described diabetic and non-diabetic lumbosacral radiculoplexus neuropathy ("DLRPN") pathophysiology and treatment. Resp. Ex. E, Tab 2.[16] The article explained that DLRPN is "well recognized, unlike the non-diabetic lumbosacral radiculoplexus neuropathy ("LSRPN")" and that "both disorders are a lumbosacral plexus neuropathy associated with weight loss, often

[16] Dyck, James B. and Windebank, Anthony J., *Diabetic and Nondiabetic lumbosacral radiculoplexus neuropathies: New Insights Into Pathophysiology and Treatment,* 25 Muscle and Nerve 477-491 (2002). [Resp. Ex. E, Tab 2].

beginning focally or asymmetrically in the thigh or leg, but usually progressing to involve the initially unaffected segment and the contralateral side." *Id.* at 1. Dr. Callaghan argued that the *Dyck* article demonstrates that diabetic lumbosacral radiculplexus neuropathy is much more common than the "version that occurs in those without diabetes." Resp. Ex. E at 1. However, the authors of *Dyck* explain that the limited knowledge of non-diabetic lumbosacral radiculplexus is "limited because of the small number of patients, lack of prolonged follow-up, lack of sensory or autonomic test evaluations, and the relatively recent recognition of LSRPN as a separate condition." Resp. Ex. E, Tab 1 at 3.

In his third report, Dr. Callaghan asserted that Dr. Chen's opinion that petitioner did not have diabetic cervical radiculoplexopathy contradicted the *Massie et al.* article, which described 85 cases of diabetic cervical radiculoplexopathy. Resp. Ex. F at 1. Dr. Callaghan argued that some of the characteristics of patients with diabetic cervical radiculoplexopathy described in the *Massie* article was consistent with the petitioner's presentation. *Id.* at 1. Specifically, Dr. Callaghan stated that 65% of cases studied occurred without weight loss and 48% of patients with diabetic cervical radiculoplexopathy had only one side affected, which would be similar to the petitioner's presentation. *Id.*; *see also* Pet. Ex. 26 at 8.

Finally, Dr. Callaghan opined that petitioner's "longstanding diabetes" was also the cause of his adhesive capsulitis. Resp. Ex. E at 2; Resp. Ex. F at 1. He stated that "the petitioner's concomitant adhesive capsulitis is also likely caused by diabetes, providing further evidence to support diabetes as the underlying cause of both conditions." *Id.* It was Dr. Callaghan's opinion that the timing of petitioner's adhesive capsulitis "at the same time as the brachial neuritis lends further evidence that diabetes is the likely cause." He stated, "The most common condition that causes adhesive capsulitis is diabetes." *Id.* Dr. Callaghan asserted that the *Zreik et al.* article "revealed that patients with diabetes are 5 times more likely to develop this condition compared to those without diabetes. Resp. Ex. A, Tab 2.[17] The *Zreik* article reviewed literature that studied the prevalence of adhesive capsulitis in diabetes. *Id.* The authors found "an overall mean prevalence of [adhesive capsulitis] in diabetes mellitus of 13.4%" and that "diabetic patients are 5 time more likely to develop adhesive capsulitis compared to non-diabetic controls." *Id.* at 3.

Dr. Callaghan concluded that the intradermal flu vaccine petitioner received was not the cause of his brachial neuritis, but it was petitioner's diabetes. Resp. Ex. E at 3; Resp. Ex. F at 2. He stated, "the most likely cause of both [adhesive capsulitis and cervical radiculoplexopathy] is diabetes, especially considering the long duration and lack of control of petitioner's diabetes." *Id.*

2. Dr. S. Mark Tompkins opinion on vaccine causation

Dr. S. Mark Tompkins, a Ph.D. immunologist, wrote two reports for respondent. Resp. Ex. C, G. Summarizing the conclusion of both reports, Dr. Tompkins' opinion is that petitioner's "pre-existing conditions" which are "associated with neuropathy remain the most medically reliable explanations for the onset of petitioner's neuropathy." Resp. Ex. C at 7; Resp.

[17] Zreik, N., *Adhesive capsulitis of the shoulder and diabetes: a meta-analysis of prevalence,* 6 Muscles, Ligaments and Tendons J., 26-34 (2016). [Resp. Ex. A, Tab 2].

Ex. G at 3. He stated that Drs. Beyers and Chen opinions that the intradermal flu vaccine can cause brachial neuritis are not supported by the medical literature. Resp. Ex. C at 7.

In his first report, Dr. Tompkins acknowledged that post-marketing reporting for the intradermal vaccine includes reports of brachial neuritis, but states that "post-marketing reporting does not infer causality." Resp. Ex. C at 7. He argued that because brachial neuritis is listed as an adverse event in other injectable vaccines' post-marketing data, "brachial neuritis is not *specifically* associated with intradermal vaccinations as Dr. Chen suggests." *Id.* He asserted that the medical literature that Drs. Byers and Chen reference, specifically the *Feinberg* and *van Alfen* articles, do not propose a specific mechanism of how brachial neuritis can be caused by vaccination. *Id.* at 3.

In his two reports, Dr. Tompkins conceded that brachial neuritis can be an immune-mediated disease. Resp. Ex. C at 3; Resp. Ex. G at 2. He stated that the *Van Eijk et al.* article provides, "[BP] can be categorized as an organ-specific immune-mediated disorder. The immune hypothesis is supported by the fact that half of affected patients report antecedent events that trigger the immune system, mostly infections, but also surgery, childbirth, and physical or mental strain." *Id.*; Resp. Ex. C, Tab 1.[18] Attempting to distinguish his opinion from Drs. Byers and Chen, he asserted that brachial neuritis is caused by "an adaptive immune response." Resp. Ex. C at 4. Referencing the 2011 *van Alfen* article, Dr. Tompkins argued that the biopsies of brachial neuritis patients "demonstrated T cell and other lymphocytic infiltrates in sensory nerves." Resp. Ex. C at 4. Specifically, *van Alfen* states, "Peripheral sensory nerve biopsy samples from patients with subacute neuralgic amyotrophy showed epineural perivascular T-cell infiltrates and CD20+ B-lymphocyte germinal centers around the dorsal ganglion." Pet. Ex. 20, Tab D at 6. Further, the article states that, "Other studies have found increased levels of complement C5b-C9 and decreased levels of complement C3 without signs of immune complexes in patients with acute neuralgic amyotrophy." *Id.* van Alfen continues, stating, "A study that characterized patients' T-lymphocyte subsets during the acute phase of neuralgic amyotrophy reported a decrease of CD8+T-suppressor lymphocytes-a profile also seen in autoimmune PNS disorders, such as Guillain-Barré syndrome and recurrent Bell palsy." *Id.*

Dr. Tompkins stated that "the window between preceding event and onset of disease ranges from hours to weeks," and "[w]hile the rapid onset of symptoms might suggest an innate immune response, the infectious immune response that are argued to be triggers of brachial neuritis may not be primary immune responses." Resp. Ex. C at 4. He stated that the *Suarez* article found the "presence of a "reactive germinal center with B lymphocytes," in one brachial neuritis sample, demonstrating the presence of memory immune cells and tissues in brachial plexus biopsies." *Id.* However, the *Suarez* article referenced by Dr. Tompkins, actually reviewed samples of four patients with brachial plexus neuropathy, and all four biopsies revealed, "Conspicuous mononuclear inflammatory infiltrates…surrounding epineurial and endoneurial vessels." Pet. Ex. 38. Additionally, the authors found that only one of the four patients had a "reactive germinal center with small cleaved and large noncleaved CD20-positive B lymphocytes" but all four patients' infiltrates were composed of T-lymphocytes. *Id.* at 1. The authors wrote, "The main observation from this series of patients with BPN was the presence of

[18] Van Eijk, Jeroen, et al., *Neuralgic Amyotrophy: An Update on Diagnosis, Pathophysiology, and Treatment,* 53 Muscle & Nerve 337-350 (2016). [Resp. Ex. C, Tab 1].

prominent collections of inflammatory cells (especially T lymphocytes) within the brachial plexus." *Id.*

Then Dr. Tompkins argued that the intradermal flu vaccine does not elicit an increased cytokine response, as Drs. Byers and Chen asserted in their reports. Resp. Ex. C at 5. Dr. Tompkins agreed with Dr. Byers that the intradermal vaccines "may elicit inflammatory cytokines, such as TNF-α and IL-1β, or IL-6," but argued that her statement is based on "established basic literature for intradermal vaccination and epidermal immunity, but there is limited evidence for this during intradermal influenza vaccination in humans." *Id.* He asserted *Tozuka et al.*, which is a study of early immune responses following the intradermal flu vaccination in mice, demonstrates that the "improved immunogenicity of intradermal vaccination may be the result of improved antigen delivery to the draining lymph node." *Id.* at 5. Dr. Tompkins wrote that, "The extensive distribution of lymphatic vessels in skin, compared to muscle, enabled efficient delivery of antigen to draining lymph nodes." Dr. Tompkins also stated that the *del Pilar Martin et al.* article found increases of TNF-α and IL-1β, which are inflammatory cytokines, six and 12 hours after mice were vaccinated with microneedle patches. *Id.* at 5; *see also* Resp. Ex. C, Tab 6.[19] The *del Pilar Martin* study examined cytokine expression in the skin of mice after microneedle vaccination to better understand how intradermal vaccinations confer protective immunity. Resp. Ex. C, Tab 6 at 1. The authors found "significant increases in the levels of cytokines IL-1β, macrophage inflammatory protein 1 alpha (MIP-α), tumor necrosis factor alpha (TNF-α), and monocyte chemoattractant protein 1 (MCP-1)," after microneedle insertion alone, but increased further when using a microneedle coated with the influenza vaccine. *Id.* at 2. The authors wrote, "The increase of these cytokine expression levels has been demonstrated to contributed to the regulation of epidermal Langerhans cell migration and the subsequent accumulation of dendritic cells in the draining lymph nodes, in addition to the role in neutrophil and monocyte recruitment." *Id.* Further, the authors stated, "The skin cytokine profile analysis shows that skin immunization induces a local innate immune response and a release of chemokines in the skin suggestive of the activation and recruitment of immune cells to the site of vaccination." *Id.* Dr. Tompkins acknowledges that this study shows that some proinflammatory cytokines were increased at intradermal injection sites, but argued that the study does not compare innate immune responses to intramuscular flu vaccines, "so we cannot conclude that the cytokine levels elicited by microneedle patch vaccination were greater than the standard influenza vaccination method." Resp. Ex. C at 5.

To further his argument that the intradermal flu vaccine does not "elicit a cytokine storm that might be involved in causing brachial neuritis or other neuroinflammatory events," Dr. Tompkins compares the immunogenicity of the intradermal flu vaccine to the flu vaccine delivered intramuscularly. Resp. Ex. C at 5-6. He asserted that the *Beran et al.* study "directly compared the safety and immunogenicity of 9µg intradermal flu vaccine to 15 µg intramuscular flu vaccine and concluded the intradermal vaccine "showed comparable immunogenic and safety profiles to intramuscular vaccination."" *Id.* at 6; *see also* Resp. Ex. C, Tab 10.[20] The *Beran*

[19] del Pilar Martin, Maria, et al., *Local response to Microneedle-Based Influenza Immunization in the Skin,* 3 mBio doi:10.1128/mBio.00012-12 (2012). [Resp. Ex. C, Tab 6].

[20] Beran, Jiri, et al., *Intradermal influenza vaccination of healthy adults using a microinjection system: a 3-year randomised controlled safety and immunogenicity trial,* 7 BMC doi:10.1186/1741-7015-7-13 (2009). [Resp. Ex. C, Tab 10].

study was a randomized controlled study where patients received the flu vaccine either by intradermal injection or intramuscular injection. Resp. Ex. C, Tab 10 at 1. The authors did find the immunogenicity between the intradermal and intramuscular flu vaccines to be comparable, as Dr. Tompkins asserted. *Id*. at 7. More relevant to this case, however, is that the study also found increased local injection site reactions were more frequently reported with patients who received the intradermal vaccination. *Id*. at 13. The authors found that erythema was the most common local reaction with the intradermal vaccine, "typically appearing within 3 days of vaccination." *Id*. at 7. Thirty seven percent of patients who received the intradermal vaccination reported pain at the injection site, slightly below the 39% of patients who received the intramuscular vaccination. *Id*. at 12. Further, the study found that induration at the injection site was higher in those who received the intradermal vaccination compared to patients who received the intramuscular vaccine. *Id*. The authors stated that the "increase in local reactions is linked to the underlying inflammatory or immunological response in the skin, which is more visible with ID than IM vaccination." *Id*. at 13. Dr. Tompkins argued that the local immune reactions are "atypical compared to intramuscular vaccination." Resp. Ex. C at 6.

In his supplemental report, he again averred that the flu vaccine delivered intradermally and intramuscularly "elicit similar inflammatory responses," and that a local inflammatory response triggered by the intradermal flu vaccine could not result in brachial neuritis. Resp. Ex. G at 3. He acknowledged that the cytokine response from the intradermal flu vaccine is elevated, but argued that this elevation in cytokines, along with dendritic cells would migrate to the draining lymph nodes to activate antigen specific adaptive immune cells, "does not suggest a localized response in the lymph node could trigger brachial neuropathy." *Id*. Dr. Tompkins refers to the Institute of Medicine ("IOM") Report on Adverse Reactions to Vaccines to support his opinion that the flu vaccine cannot result in an increased cytokine activation, as proposed by Dr. Chen. *Id*. The relevant part from the IOM which Dr. Tompkins quoted provides, "In review of the relevant literature related to the vaccine and adverse event combinations considered by the committee, no evidence that directly or indirectly supports the over secretion of cytokines as an operative mechanism was found." Resp. Ex. G, Tab T at 105.[21] Dr. Tompkins wrote, "In other words, there is no evidence that cytokine cascades cause adverse events." Resp. Ex. G at 3. However, Dr. Tompkins fails to mention that the IOM also wrote:

> Although the committee is not aware of reports of full-blown cytokine storm following administration of any of the vaccines reviewed, more subtle imbalances of proinflammatory and anti-inflammatory cytokines may occur following immunization against rubella, human papillomavirus, or hepatitis B. Moreover, it is possible that the unique immunogenetic makeup of an individual might predispose that individual to an exaggerated cytokine imbalance following immune stimulation such as microbial infection or vaccine administration.

Resp. Ex. G, Tab 1 at 105.

Finally, Dr. Tompkins agreed with Dr. Callaghan's opinion that petitioner most likely experienced neuropathy because of his underlying diabetes. Resp. Ex. G at 1; Resp. Ex. C at 6. He stated, "…as Dr. Callaghan notes, rates of neuropathy are increased in persons with diabetes

[21] Institute of Medicine, *Adverse Effects of Vaccines: Evidence and Causality* (2012). [Resp. Ex. G, Tab 1].

mellitus and [petitioner's] records note a diagnosis of diabetes mellitus and increased hemoglobin A1c and glucose since at least November 2011." *Id.* at 6. He also stated that the *Iqbal (cite)* article found that the "incidence of neuropathy to be up to ten times higher in diabetics compared to controls in two cohort studies." *Id.* at 7. Then, somewhat paradoxically, Dr. Tompkins opined that petitioner's shoulder pathology of a partial rotator cuff tear and rotator cuff tendinitis could result in "increased levels of proinflammatory cytokines, including IL-1β, IL-6, and TNF-α" which could be the trigger for immune mediated brachial neuritis. *Id.* Dr. Tompkins also contended that another possible cause of petitioner's brachial neuritis is herpes recrudescence. *Id.* He cited to an article which provides a case report of one individual with "relapsing-remitting facial and brachial plexus neuritis caused by HSV-1." *Id.* Dr. Tompkins based his opinion that it could be possible that petitioner had an HSV-1 recurrence by petitioner's prescription for Valtrex, but acknowledged that "herpes recrudescence is not noted in petitioner's medical records." *Id.* Dr. Tompkins states that "repeated HSV recrudescence events could have provided the neuronal inflammation triggering petitioner's brachial neuropathy." *Id.* Dr. Tompkins does appear to drop this argument in his supplemental expert report.

Dr. Tompkins concluded both reports stating that, "The pre-existing conditions associated with neuropathy remain the most medically reliable explanation for the onset of petitioner's neuropathy." Resp. Ex. C at 7; Resp. Ex. G at 3. He stated that, "Each of these triggers are associated with brachial neuropathy, and have proposed mechanisms involving eliciting pro-inflammatory cytokine responses to damage the neuron, or directly causing neuronal damage through virus infection and bystander immune damage." Resp. Ex. C at 7.

III. Legal Standard

The Vaccine Act was established to compensate vaccine-related injuries and deaths. Section 10(a). "Congress designed the Vaccine Program to supplement the state law civil tort system as a simple, fair and expeditious means for compensating vaccine-related injured persons. The Program was established to award 'vaccine-injured persons quickly, easily, and with certainty and generosity.'" *Rooks v. Sec'y of Health & Human Servs.,* 35 Fed. Cl. 1, 7 (1996) (quoting H.R. No. 908 at 3, *reprinted in* 1986 U.S.C.C.A.N. at 6287, 6344).

A petitioner bears the burden of establishing his or her entitlement to compensation from the Vaccine Program. The burden of proof is by a preponderance of the evidence. Section 13(a)(1).

A. Nature of Injury

The Federal Circuit established the test for actual causation of an off-Table injury in *Althen*, 418 F.3d at 1278. In that case: "There was no dispute as to whether the petitioner, Margaret Althen, actually suffered from a central nervous system demyelinating disorder. Therefore, the Federal Circuit was not presented with a case in which the diagnosis itself was questioned, but one in which causation of the injury by the vaccine was the issue in dispute." *Doe v. Sec'y of Health & Hum. Servs.*, 94 Fed. Cl. 597, 611 (2010) (citing *Althen*, 418 F.3d at 1282), *aff'd, Lombardi v. Sec'y of Health & Hum. Servs.*, 656 F.3d 1343 (Fed. Cir. 2011).

Special masters are generally not tasked with diagnosing injuries. In *Lombardi*, the Federal Circuit explained: "The function of a special master is not to 'diagnose' vaccine-related injuries, but instead to determine 'based on the record evidence as a whole and the totality of the case, whether it has been shown by a preponderance of the evidence that a vaccine caused the petitioner's injury.'" *Lombardi*, 656 F.3d at 1343, *citing Andreu v. Sec'y of Health & Hum. Servs.*, 569 F.3d 1367, 1382 (Fed. Cir. 2009).

However, the Federal Circuit has determined that in certain instances, "if there is a dispute as to the nature of a petitioner's injury, the special master may opine on the nature of the petitioner's injury." *Contreras v. Sec'y of Health & Hum. Servs.*, 844 F.3d 1363, 1368 (Fed. Cir. 2017), *citing Hibbard v. Sec'y of Health & Hum. Servs.*, 698 F.3d 1355 (Fed. Cir. 2012); *see also Locane v. Sec'y of Health & Hum. Servs.*, 686 F.3d 1375 (Fed. Cir. 2012); *Broekelschen v. Sec'y of Health & Hum. Servs.*, 618 F.3d 1339 (Fed. Cir. 2010)).

In *Hibbard*, the Federal Circuit reasoned: "If a special master can determine that a petitioner did not suffer the injury that she claims was caused by the vaccine, there is no reason why the special master should be required to undertake and answer the separate (and frequently more difficult) question whether there is a medical theory, supported by 'reputable medical or scientific explanation,' by which a vaccine can cause the kind of injury that the petitioner claims to have suffered." 698 F.3d at 1365.

While the special master is not required to reach a specific diagnosis, the special master may appropriately evaluate at least the nature of petitioner's injury and whether that aligns with petitioner's theory. For example, in *Broekelschen*, the petitioner posited "transverse myelitis [which] is an inflammatory event caused by an immune response," while the respondent posited "anterior spinal artery syndrome, [which] is a vascular event caused by a blockage." 618 F.3d at 1346. The Federal Circuit observed: "Nearly all of the evidence on causation was dependent on the diagnosis" and because the injury itself [was] in dispute, the proposed injuries differ[ed] significantly in their pathology, and the question of causation turn[ed] on which injury [the petitioner] suffered." *Id.* Accordingly, the Federal Circuit held "it was appropriate… for the special master to first determine which injury was best supported by the evidence presented in the record before applying the *Althen* test so that the special master could subsequently determine causation relative to the injury." *Id.*

In contrast, in *Contreras*, the Court of Federal Claims held that the special master erred by diagnosing the petitioner's illness – as TM and not Guillain-Barré syndrome ("GBS") – before evaluating the *Althen* prongs. 107 Fed. Cl. 280, 292-93. The Court reasoned that the case contained "ample evidence that TM and GBS are similar diseases with similar pathologies" and the parties' "unified position [was] that an exact diagnosis of [the petitioner's illness] was not required to rule on causation." *Id.* at 293. The Court of Federal Claims articulated that "the general rule is that the special master should not conduct a differential diagnosis, at the outset of the causation analysis, to choose one diagnosis over another, or over a combination of diagnoses." *Id.*, *aff'd* 844 F.3d 1363; *see also Andreu*, 569 F.3d 1367, 1378 (holding that the special master need not determine whether an initial seizure was febrile or afebrile for purposes of assessing vaccine causation).

Relevant to this inquiry, the Vaccine Act provides that a special master must consider the record as a whole including any medical diagnosis contained therein. Section 300aa-13(b)(1). However, no diagnosis in the medical records is "binding on the special master." *Id*. Rather, "[i]n evaluating the weight to be afforded to any such diagnosis… the special master… shall consider the entire record and the course of the injury, disability, illness, or condition until the date of the judgment of the special master." *Id*. The special master shall also consider any expert opinions and additional medical scientific evidence in the record. *Id*.

B. Causation

A petitioner may prevail by proving either that (1) the vaccinee suffered an injury listed on the Vaccine Injury Table with onset beginning within a corresponding time period following receipt of a corresponding vaccine (a "Table Injury"), for which causation is presumed or that (2) the vaccinee suffered an injury that was actually caused by a vaccine. Under either method, however, the petitioner must also show that the vaccinee "suffered the residual effects or complications of the illness, disability, injury, or condition for more than six months after the administration of the vaccine." Section 11(c)(1)(D)(i).

In the present case, petitioner does not and cannot allege a Table injury. Thus, he bears the burden of establishing actual causation. To do so, he must "show by preponderant evidence that the vaccination brought about the injury by providing 1) a medical theory connecting the vaccination and injury; 2) a logical sequence of cause and effect showing that the vaccination was the reason for the injury; and 3) a showing of proximate temporal relationship between vaccination and injury." *Althen v. Sec'y of Health & Human Servs.*, 418 F. 3d 1274, 1278 (Fed. Cir. 2005). There must be preponderant evidence for each *Althen* prong. *Caves v. Sec'y of Health & Human Servs.*, 100 Fed. Cl. 119, 132 (2011), *aff. per curiam*, 463 Fed. Appx. 932 (Fed. Cir. 2012).

Under *Althen* prong one, the causation theory must relate to the injury alleged. Thus, a petitioner must provide a "reputable" medical or scientific explanation that the vaccine received *can cause* the type of injury alleged. *Pafford*, 451 F.3d at 1355-56. The theory must be based on a "sound and reliable medical or scientific explanation." *Knudsen*, 35 F.3d at 548. It must only be "legally probable, not medically or scientifically certain." *Id*. at 549. However, the theory still must be based on a "sound and reliable medical or scientific explanation." *Id*. at 548. The Federal Circuit explained in *Althen* that "while [that petitioner's claim] involves the possible link between [tetanus toxoid] vaccination and central nervous system injury, *a sequence hitherto unproven in medicine*, the purpose of the Vaccine Act's preponderance standard is to allow the finding of causation in a field *bereft of complete and direct proof of how vaccines affect the human body." Althen*, 418 F.3d at 1280 (emphasis added).

Under *Althen* prong two, petitioner must prove "a logical sequence of cause and effect showing that the vaccination was the reason for [her] injury." *Althen*, 418 F.3d at 1278. This prong is sometimes referred to as the "did it cause" test; i.e. in this particular case, did the vaccine(s) cause the alleged injury. *Broekelschen*, 618 F. 3d at 1345 ("Because causation is relative to the injury, a petitioner must provide a reputable medical or scientific explanation that pertains specifically to the petitioner's case"). Temporal association alone is not evidence of

causation. *See Grant v. Sec'y of Health & Human Servs.,* 9556 F.2d 1144, 1148 (Fed. Cir. 1992). This sequence of cause and effect is usually supported by facts derived from petitioner's medical records. *Althen,* 418 F.3d at 1278; *Andreu,* 569 F.3d at 1375-77; *Capizzano,* 440 F.3d at 1326; *Grant,* 956 F.2d at 1148.

Althen prong three requires establishing a "proximate temporal relationship" between the vaccination and the injury alleged. *Althen* at 1281. That term has equated to the phrase "medically-acceptable temporal relationship." *Id.* A petitioner must offer "preponderant proof that the onset of symptoms occurred within a timeframe which, given the medical understanding of the disorder's etiology, it is medically acceptable to infer causation." *de Bazan v. Sec'y of Health & Human Servs.,* 539 F.3d 1347, 1352 (Fed. Cir. 2008). The explanation for what is medically acceptable timeframe must align with the theory of how the relevant vaccine can cause an injury (*Althen* prong one). *Id.* at 1352.

The preponderance of the evidence standard requires the petitioner to demonstrate that it is "more likely than not" that the vaccine caused the injury. *Moberly v. Sec'y of Health & Human Servs.,* 592 F.3d 1315, 1322 n.2 (Fed. Cir. 2010). Proof of medical certainty is not required. *Bunting v. Sec'y of Health & Human Servs.,* 931 F.2d 867, 873 (Fed. Cir. 1991). A petitioner must demonstrate that the vaccine was "not only [a] but for cause of the injury but also a substantial factor in bringing about the injury." *Moberly,* 592 F.3d at 1321 (quoting *Shyface v. Sec'y of Health & Human Servs.,* 135 F.3d 1344, 1352-53 (Fed. Cir. 1999); *Pafford v. Sec'y of Health and Human Servs.,* 451 F.3d 1352, 1355 (Fed. Cir. 2006). Causation is determined on a case-by-case basis, with "no hard and fast *per se* scientific or medical rules." *Knudsen v. Sec'y of Health & Human Servs.,* 35 F.3d 543, 548 (Fed. Cir. 1994). A fact-finder may rely upon "circumstantial evidence" which is consistent with the "system created by Congress, in which close calls regarding causation are resolved in favor of injured claimants." *Althen,* 418 F. 3d at 1280.

The petitioner often presents expert testimony in support of his or her claim. *Lampe v. Sec'y of Health & Human Servs.,* 219 F.3d 1357, 1361 (Fed. Cir. 2000). Expert testimony in the Vaccine Program is usually evaluated according to the factors set forth in *Daubert v. Merrell Dow Pharm., Inc.,* 509 U.S. 579, 594-96 (1993); *see also Cedillo,* 617 F.3d at 1339 (citing *Terran v. Sec'y of Health & Human Servs.,* 195 F.3d 1302, 1316 (Fed. Cir. 1999). A special master may use the *Daubert* framework to evaluate the reliability of expert testimony, but expert testimony need not meet each *Daubert* factor to be reliable. *Boatmon v. Sec'y of Health & Human Servs.,* 941 F.3d 1351 (Fed. Cir. 2019). The *Daubert* factors are "meant to be helpful, not definitive," and all factors "'do not…necessarily apply even in every instance in which the reliability of scientific testimony is challenged.'" *Boatmon,* 941 F. 3d at 1359 (citing *Kumho Tire Co. v. Carmichael,* 526 U.S. 137, 151, 119 S. Ct. 1167, 143 L.Ed.2d 238 (1999). Thus, for Vaccine Act claims, a "special master is entitled to require some indicia of reliability to support the assertion of the expert witness." *Moberly* at 1324. Where both sides offer expert testimony, a special master's decision may be "based on the credibility of the experts and the relative persuasiveness of their competing theories." *Broekelschen v. Sec'y of Health & Human Servs.,* 219 F.3d 1339, 1347 (Fed. Cir. 2010) (citing *Lampe,* 219 F.3d 1357 at 1362).

If the petitioner makes a *prima facie* case supporting vaccine causation-in-fact, the

burden shifts to respondent to show by a preponderance of the evidence that the injury is instead due to factors unrelated to the administration of the vaccine. *Deribeaux v. Sec'y of Health & Human Servs.*, 717 F.3d 1363, 1367 (Fed. Cir. 2013) (citing Section 13(a)(1)(B)). Respondent has the burden of demonstrating that: "[A] factor unrelated to the vaccination is the more likely or principal cause of injury alleged. Such a showing establishes that the factor unrelated, not the vaccination, was 'principally responsible' for the injury. If the evidence or alternative cause is seen in equipoise, then the government has failed in its burden of persuasion and compensation must be awarded." *Knudsen*, 35 F.3d at 551.

IV. Entitlement

A. Nature of petitioner's condition

Here, the parties do not dispute that petitioner was suffering from some type of vasculitic neuropathy of the left upper extremity. *See* Pet. Ex. 19 at 3; Resp. Ex. E at 1. On August 15, 2015, an EMG/NCS revealed "severe, chronic left musculocutaneous neuropathy." Pet. Ex. 23 at 12. The Nerve Conduction Study found "the left lateral antebrachial cutaneous sensory response was absent," and the EMG found evidence of "severe chronic denervation in the left biceps muscle." *Id.* Petitioner's treating physician, Dr. Huffman, who also provided an expert opinion in this matter, diagnosed petitioner with "Parsonage-Turner syndrome." *Id.* at 10.

The parties dispute whether petitioner has brachial neuritis or diabetic cervical neuropathy. *See* Pet. Ex. 19, 25; Resp. Ex. A, E & F. Petitioner contends that he has brachial neuritis that began three days post-vaccination and was correctly diagnosed by Dr. Huffman with adhesive capsulitis occurring subsequently and secondary to the painful brachial neuritis. Respondent argued that the correct diagnosis for petitioner is diabetic cervical radiculoplexopathy, due to petitioner's long-standing diabetes. Resp. Brief at 20; Resp. Ex. E at 1.

1. Neurologic amyotrophy

Neurologic amyotrophy, which is referred to as Parsonage-Turner syndrome or brachial neuritis, is a "markedly underdiagnosed" disorder. Pet. Ex. 32 at 1; Resp. Ex. C, Tab 3; Pet. Ex. 20, Tab D at 1. According to two articles written by Nens van Alfen, which both parties referenced, neurologic amyotrophy "is a distinct and painful peripheral neuropathy that causes episodes of multifocal paresis (weakness)and sensory loss in a brachial plexus distribution with concomitant involvement of other peripheral nervous system structures." Pet. Ex. 20, Tab D at 1. The core features include episodes of "extreme pain at symptom onset, rapid multifocal paresis and atrophy of the upper extremity muscles, and a slow recovery." *Id.*

van Alfen explained, "The minimum incidence of neuralgic amyotrophy is 2-3 cases per 100,000 individuals in the general population per year, but under recognition and misdiagnosis are frequent and the true annual incidence could be 20-30 cases per 100,000 individuals." Pet. Ex. 20, Tab D. Neurologic amyotrophy can be misdiagnosed with rotator cuff tendinopathy,

cervical radiculopathy, glenohumeral bursitis, or muscle strain. Pet. Ex. 32 at 2.[22]

A distinct feature of neurologic amyotrophy is neuropathic pain at onset. Resp. Ex. C, Tab 3 at 4,10; Pet. Ex. 20, Tab D at 2. In 96% of patients the pain is characterized as "acute" and "severe" in the upper extremities, neck and/or trunk. Pet. Ex. 20, Tab D at 2. After the initial onset of pain, the pain severity increases within hours and can last for four weeks, on average. *Id.* at 2; Resp. Ex. C, Tab 3 at 4. After initial pain, weakness then begins to appear within 24 hours to two weeks. Resp. Ex. C, Tab 3 at 5. In men, the mean time to onset of weakness from the initial presentation of pain was 13.6 days. *Id.* In van Alfen's study of 246 patients, she found that paresis in the distribution of the upper part of the brachial plexus was the most common. *Id.*; Pet. Ex. 20, Tab D at 2. Bilateral asymmetric symptoms are seen in one third of cases. Pet. Ex. 20, Tab D at 2. Additionally, approximately 70% to 80% of patients have sensory symptoms, such as hyperesthesia and/or paresthesia. Pet. Ex. 32 at 3; *see also* Resp. Ex. C, Tab 3 at 5.

Diagnosing neurologic amyotrophy "is based on a patient's clinical history and physical examination." Pet. Ex. 32 at 4. Electrophysiological studies are not often observed in the acute stage, as "abnormal findings are only manifested after 1 and 3 weeks of onset of neurological amyotrophy in nerve conduction studies and electromyography, respectively." *Id.* Van Alfen also explained that "many patients are initially diagnosed with shoulder joint pathology…or cervical radiculopathy (in a neurological setting)." Pet. Ex. 20, Tab D at 4. The review article explains that cervical radiculopathy can be distinguished from NA "by the fact that all symptoms and signs can be localized to the distribution of a single root level in a patient with radiculopathy, but not in patients with NA." *Id.*

The *van Eijk* article explains that nerve conduction studies (NCS) for patients with NA can "fail to show abnormalities in 80% of patients, even with clinically affected nerves are studied." Resp. Ex. C, Tab 1 at 7. The same article also cautions the use of EMG in NA, because "[m]any of the muscles involved in NA do not belong to the routine set of muscles that practitioners commonly explore during their EMG evaluation." *Id.* However, when nerve conduction and electromyography studies of patients with NA are done, they have shown axonal damage, reduced motor conduction velocity, and prolonged F-wave latencies. Pet. Ex. 38 at 3.

The *van Alfen*, *Kim*, and *van Eijk* articles also endorse a "multifactorial etiology," for neuralgic amyotrophy, including underlying genetics, mechanical (repetitive strain or strenuous exercise), or a possible immunological trigger. *See* Pet. Ex. 20, Tab D; Pet Ex. 32 at 2; Resp. Ex. C, Tab 1 at 1. All three articles explain that no specific immunological triggers have been identified for neuralgic amyotrophy, but the fact that ">50% of patients with neuralgic amyotrophy report an immune event before an attack led to the hypothesis that attacks are immunologically precipitated." Pet. Ex. 20, Tab D at 6; *see also* Resp. Ex. C, Tab 1 at 3. Different types of immunological events, such as infection, vaccination, surgery, pregnancy, childbirth, and immunotherapy, have been reported as preceding events. *Id.*

Treatment for NA consists of oral prednisolone, physical therapy, non-steroidal anti-

[22] Kim, T. and Chang, M, *Neuralgic amyotrphy: an underrecognized entity,* 49 J. of Int'l Med. Research, 1-7 (2021). [Pet. Ex. 32].

inflammatory drugs, and immobilization to minimize pain. Pet. Ex. 32 at 4; Pet. Ex. 20, Tab D at 6. In the acute phase of the disease, a two-week regime of steroids is recommended. Pet. Ex. 20, Tab D at 6. According to the *Kim* article, patients with NA recover 80% to 90% of their previous state in 2 to 3 years, but more than 70% of patients experience residual motor weakness. Pet. Ex. 32 at 5.

2. Diabetic cervical radiculoplexus neuropathy

Diabetic cervical radiculoplexus neuropathy is a neuropathy that arises in persons with diabetes. Resp. Ex. A, Tab 1; Pet. Ex. 20, Tab N.[23] Dr. Callaghan accurately explains that diabetic lumbosacral radiculoplexopathy is more common that diabetic cervical radiculoplexopathy, both conditions arise secondary to diabetes. Resp. Ex. F at 1. The *Massie* article, cited by Drs. Chen and Callaghan, states, "Diabetes mellitus is widely accepted to be associated with lumbosacral radiculoplexus neuropathy, but only rarely has the existence of diabetic *cervical* radiculoplexus neuropathies (DCRPN) been postulated." Resp. Ex. A, Tab 1 at 2. The article observes that another study found that 12 out of 44 patients with severe diabetic lumbosacral radiculoplexopathy also had "upper extremity involvement." *Id*. The authors of *Massie* explained that their study was the first to explore cervical radiculoplexus neuropathies in diabetes mellitus and they sought to determine the clinical features, laboratory studies, neurophysiological findings, neuroimaging, and pathological features independent of this disease, separate from diabetic lumbar radiculoplexus neuropathy. *Id*.

The authors studied 85 patient cases who had diabetes and a history of upper extremity pain, paresthesia or weakness and neurological examinations and/or electrophysiological abnormalities localizing the process to the cervical nerve roots, brachial plexus or upper extremity nerves. Resp. Ex. A, Tab 1 at 3. They observed that the median age for onset was 62 years and the median duration of diabetes mellitus or impaired fasting glucose was 5.5 years. *Id*. Additionally, most patients had Type 2 diabetes. *Id*. The study observed that pain was the main initial symptom. *Id*. Further, *Massie* explained that the onset was acute and predominantly affected one side with "subsequent spread to the contralateral side" in 30 out of 85 patients. *Id*. Sensory symptoms appeared in 66% of cases, with tingling/paresthesia and numbness as the predominant sensory symptoms. *Id*. at 5. Thirty of the 85 patients had experienced weight loss greater than 10 pounds. *Id*. Half of the patients with DCRPN had involvement of other regions of the peripheral nervous system, including thoracic radiculopathy, lumbosacral radiculoplexus neuropathy, and Horner's syndrome. *Id*. Nerve conduction studies performed in 80 of the 85 patients were consistent with a predominantly axonal process. *Id*. at 6. Further, conduction velocities and distal latencies were generally only minimally abnormal. *Id*. Out of the 80 patients with EMG/NCS studies, demyelinating features were only observed in 10 patients and "consisted most commonly of conduction blocks." *Id*. The needle examinations revealed "frequent fibrillation potentials in almost all patients with decreased recruitment of large amplitude, long duration polyphasic motor unit potentials." *Id*.

The *Laughlin* article explained that in patients with DCRPN, all levels of the brachial plexus are involved, compared to nondiabetic brachial plexopathies in which the upper trunk of

[23] Massie, R. et al., *Diabetic cervical radiculoplexus neuropathy: a distinct syndrome expanding the spectrum of diabetic radiculolplexus neuropathies,* 135 Brain 3074-3088 (2012). [Resp. Ex. A, Tab 1; Pet. Ex. 20, Tab N].

the brachial plexus is "preferentially involved." Pet. Ex. 28 at 4.[24] This is consistent with the *Massie* article, which found that "all three levels of the brachial plexus were involved," in DCRPN. Resp. Ex. A, Tab 1 at 7. *Massie* found that, "The upper plexus was involved in 45 out of 80 patients, the middle plexus in 39 out of 80 patients, and the lower plexus in 46 out of 80 patients. Pan-plexus electrophysiological involvement (all three levels simultaneously) occurred in 24 out of 80 patients." *Id.*

Treatment for DCRPN consists of immunotherapy, which includes oral or intravenous steroids, immunoglobulin or plasmapheresis. Resp. Ex. A, Tab 1 at 7; Pet. Ex. 28 at 5. The neuropathological abnormalities in DCRPN showed "evidence of ischaemic injury…and of microvasculitis." Resp. Ex. A, Tab 1 at 12.

The authors of *Massie* also compared their patient cohort to the patients studied by van Alfen and van Engelen and stated, "Our patients are generally distinct from patients with idiopathic and hereditary neuralgic amyotrophy by their autonomic features, more frequent weight loss, common bilateral upper limb and lower trunk involvements, and co-occurring thoracic and lumbosacral radiculoplexus neuropathies." Resp. Ex. A, Tab 1 at 14. *Massie* observed that the patients from his study had "more involvement outside of the brachial plexus (38% versus 17%) and had more involvement of the lower trunk of the brachial plexus (58% versus 14%)" compared to the patients studied by van Alfen and van Engelen. *Id.* Further, Massie explained that "almost all [of our patients] had evidence of autonomic dysfunction," and that "The degree of autonomic involvement was more than would be expected from the degree of glucose dysregulation and is typical of other diabetic radiculoplexus neuropathies." *Id.*

3. Analysis and conclusion of petitioner's injury

Petitioner's medical records, along with the expert opinions provided by Drs. Chen and Huffman, provide support for the diagnosis of neuralgic amyotrophy ("brachial neuritis" or "Parsonage Turner Syndrome"). Further, petitioner's diagnosis and disease course are most consistent with the medical literature about NA.

As described in the medical literature above, the first symptom patients complain about with neuralgic amyotrophy is acute pain. *van Alfen* explains that "In 96% of patients the pain is characterized as "acute" and "severe" in the upper extremities, neck and/or trunk. Pet. Ex. 20, Tab D at 2. In this case, at multiple medical appointments, petitioner reported onset of acute pain within a few days of receiving the flu shot and he characterized the pain as "knife-like." Pet. Ex. 2 at 89. Additionally, the *van Alfen* study found that patients with NA reported their pain at an 8 at onset and a 9 out of 10 a maximum intensity. Resp. Ex. C, Tab 3 at 4. At petitioner's physical therapy evaluation, he rated his pain as an 8 out of 10 at its "best" but a 9 out of 10 at its "worst." *See* Pet. Ex. 3 at 11. While acute pain is the presenting symptom in patients with diabetic cervical radiculoplexus and the onset of pain is typically unilateral, in about 35% of cases, the pain spreads to the other side. Pet. Ex. 20, Tab N at 3. Here, petitioner's pain remained restricted to his left arm.

[24] Laughlin, R. et al., *Diabetic radiculoplexus neuropathies*, 126 Handbook of Clin. Neurol. 45-51 (2014). [Pet. Ex. 28, Tab 5].

After the initial onset of pain in NA, "muscle weakness is [a] conspicuous finding…and occurs days to weeks after the onset of symptoms." Pet. Ex. 32 at 3. According to the *van Alfen* study, motor weakness appeared more frequently in the upper and middle of the brachial plexus, which may or may not include the long thoracic nerve. Resp. Ex. C, Tab 3 at 5. Accordingly, commonly affected muscles would be the infraspinatus, serratus anterior, supraspinatus, biceps bracii, rhomboids, and pronator teres, but "clinically any muscle could be involved." *Id*. When petitioner initially reported his left shoulder pain to Dr. Barmach on March 12, 2015, petitioner exhibited proximal and distal weakness in his left arm, compared to his right. Pet. Ex. 2 at 91. The evaluation by Dr. Gracie revealed a positive impingement sign, which is indicative of problems with the supraspinatus and the long head of the biceps brachii. *See* Pet. Ex. 3 at 5. Further, petitioner's strength was reduced in all directions during his initial physical therapy evaluation, demonstrating weakness upon elbow flexion, elbow extension, flexion, abduction, external rotation and internal rotation. Pet. Ex. 3 at 11. These movements which tested petitioner's strength are indicative of weakness in the muscles that are most affected by a brachial plexus injury. For example, the primary flexors of the elbow are the biceps brachii. Here, petitioner demonstrated decreased strength on both elbow flexion and extension.

When petitioner presented for the NCS/EMG on August 18, 2015, five months after physical therapy, petitioner continued to have weakness in his biceps. Pet. Ex. 23 at 12. The EMG confirmed "severe chronic denervation in the left biceps muscle." *Id*. After reviewing the EMG/NCS and performing a physical examination, petitioner's treating neurologist, Dr. Zager noted severe left, chronic musculocutaneous neuropathy with weakness in multiple muscles in the left arm, scapular winging, and decreased sensation in the left upper extremity. He diagnosed petitioner with Parsonage-Turner syndrome. *Id*. at 10.

Dr. Callaghan asserts that petitioner's left upper extremity disorder is more likely DCRN than brachial neuritis, because of petitioner's "concomitant adhesive capsulitis is also likely caused by diabetes." Resp. Ex. F at 1. However, this argument is unpersuasive because *van Alfen* reported that many patients with NA developed "subsequent persisting musculoskeletal-type pain," and that in approximately 17% of the patients van Alfen studied developed true frozen shoulder (glenohumeral adhesive capsulitis) during the course of the attack. Resp. Ex. C, Tab 3 at 4. Further, *van Alfen* explains that "29% [of patients with NA] developed, chronic, usually therapy-resistant, continuous pains in the previously affected region." *Id*. Consistent with the *van Alfen* article, petitioner's arm pain and weakness preceded what developed into adhesive capsulitis. Petitioner saw orthopedist, Dr. Huffman after attending physical therapy and was diagnosed with adhesive capsulitis after the onset of acute pain and weakness. *See* Pet. Ex. 6 at 29. When petitioner was evaluated by neurologist Dr. Eric Zager, he noted in petitioner's history of present illness, that petitioner's pain following the flu shot was "so severe with movement he ultimately had frozen shoulder." Pet. Ex. 23 at 10. Further, petitioner's pain and weakness continued not only after physical therapy, but after he received a steroid injection, and underwent a shoulder arthroscopy. Thus, petitioner's clinical course of developing acute pain, followed by weakness, which resulted in him developing adhesive capsulitis is consistent with the diagnosis of neuralgic amyotrophy.

Finally, petitioner's pain and weakness were limited to his left arm, which is more consistent with NA, than a diagnosis of DCRN. Dr. Chen stated that, "[petitioner's] examination

and EMG does not show any evidence of further neuropathy in other body parts. [Petitioner's] examination and EMG does not show evidence of further neuropathy in other body parts." Pet. Ex. 25 at 1. The literature submitted in this case explains that DCRN "is an acute upper limb neuropathy…which begins focally but often spreads to involve the contralateral limb, thoracic, and lumbosacral segments." Pet. Ex. 20, Tab N at 10. Further, petitioner's EMG and NCS of the left upper limb showed "evidence of severe, chronic denervation in the left biceps muscle." Pet. Ex. 23 at 12. The impression of Dr. Bird was "severe, chronic left musculocutaneous neuropathy." *Id*. Throughout the record, consistent with Dr. Chen's opinion, shows that petitioner's pain, weakness, and neuropathy is contained to his left arm. Dr. Callaghan does not dispute this fact.

Thus, consistent with the medical literature, and with the diagnosis of petitioner's treating neurologist, Dr. Zager, petitioner has demonstrated by preponderant evidence that he suffered from brachial neuritis (neuralgic amyotrophy).

B. Vaccine causation

1. *Althen* prong one

Under *Althen* prong one, the causation theory must relate to the injury alleged. Thus, a petitioner must provide a "reputable" medical or scientific explanation, demonstrating that the vaccine received *can cause* the type of injury alleged. *Pafford*, 451 F.3d at 1355-56. The theory must be based on a "sound and reliable medical or scientific explanation." *Knudsen v. Sec'y of Health & Human Servs.*, 35 F.3d 543, 548 (Fed. Cir. 1994). It must only be "legally probable, not medically or scientifically certain." *Id*. at 549. However, the theory still must be based on a "sound and reliable medical or scientific explanation." *Knudsen* at 548. The Federal Circuit explained in *Althen* that "while [that petitioner's claim] involves the possible link between [tetanus toxoid] vaccination and central nervous system injury, *a sequence hitherto unproven in medicine*, the purpose of the Vaccine Act's preponderance standard is to allow the finding of causation in a field *bereft of complete and direct proof of how vaccines affect the human body." Althen*, 418 F.3d at 1280 (emphasis added).

I find that petitioner has provided preponderant evidence of a sound and reliable medical theory explaining how the intradermal flu vaccine can cause brachial neuritis. This finding is supported by the expert opinions and medical literature filed in this case.

Petitioner's experts credibly explained that the intradermal flu vaccine takes advantage of the skin's unique and complementary immune activation pathways to rapidly process vaccine antigen while upregulating proinflammatory cells which infiltrate blood vessels, leading to vasculitis, damaging the underlying nerves. *See* Pet. Ex. 9 at 5; Pet. Ex. 19 at 2-3. Their opinion of how the intradermal flu vaccine can lead to vasculitis resulting in brachial neuritis is supported by the medical literature.

According to the *Bragazzi* and *del Pilar Martin* articles, the skin provides an optimal site for vaccination because of its "dense network of antigen presenting cells, including macrophages, Langerhans cells, and dermal dendritic cells present in the dermis and epidermis,

which are crucial in the initiation of the adaptive immune response." Resp. Ex. C, Tab 6 at 1; Pet. Ex. 20, Tab L at 5. The *Bragazzi* article, which reviewed the Fluzone intra-dermal vaccine, states that the "skin harbors immune cellular components (epidermal dendritic cells, different types of T cells, natural killer cells, B cells, mast cells and macrophages), thus constituting an immunocompetent, multi-tasking organ or a complex immune system." Pet. Ex. 20, Tab L at 5.

The *Bragazzi* article also explains the different mechanisms that take advantage of the skin's unique immunological and microvascular properties that can activate both innate and adaptive immune responses to vaccines. The "exact nature of [the mechanisms of action for intradermal vaccination] is complex," but that "the effect of the ID vaccination may be the result of three concurring complementary pathways." *Id*. at 5. *Bragazzi* refers to the first pathway as the "dermal dendritic cells-dependent pathway" and Dr. Byers described this pathway in her report. *Id*. at 5; *see also* Pet. Ex. 9 at 5. Dr. Byers described the mechanism, stating, "the dendritic cells pick up the vaccine antigen or foreign substance, they mature and produce pro-inflammatory cytokines, which promote the migration of the dendritic cells to the para-cortical area of the regional lymph nodes, which allows the dendritic cells to present the vaccine peptides to CD8+ T cells and CD4 lymphocytes." Pet. Ex. 9 at 5. The *Bragazzi* article provides additional detail about this pathway, explaining:

> The maturation, the differentiation, the acquisition of adequate immune abilities, and the migration to the paracortical area of the regional draining lymph nodes as afferent lymph veiled cells through high endothelial venules, are modulated by different signaling pathways, including increased expression of MHC antigens, co-stimulatory molecules and pro-inflammatory cytokines such as IL-1β, IL-6, IL-12 and TNF-α. These events lead to the subsequent activation of lymphocyte T CD8+, releasing interferon gamma, TNF-α, granzyme B, among other molecules, and high cytotoxic activity and memory B cells.

Id. at 6. *Bragazzi* also explains that "There is also another complementary pathway, independent of the first: antigens and especially small vaccine components are passively drained by the unique micro-vascular and lymphatic structures of the skin and transported directly to the lymph nodes, where they are captured by lymph node resident dendritic cells, medullary macrophages and subcapsular sinus macrophages." *Id*. Dr. Chen describes this complementary pathway in her first report. *See* Pet. Ex. 19 at 3. Finally, *Bragazzi* states that the actual needle injection "generates localized transient stresses invoking cell necrosis and apoptosis around each injection, favoring the release of damage associated molecular patterns (DAMPs)." Pet. Ex. 20, Tab L at 6. Dr. Chen, consistent with *Bragazzi*, opined that the "local skin injury generates molecular signals that cause inflammatory cascades via damage associated molecular signals that reside in the skin." Pet. Ex. 19 at 3.

Both Drs. Byers and Dr. Chen opined that because of the skin's unique immunological mechanisms, the intradermal flu vaccination can cause a heightened innate immune response, which leads to a rapid upregulation of cytokines to the area of the injection site. Pet. Ex. 9 at 4; Pet. Ex. 19 at 3. Respondent's expert, Dr. Tompkins agreed with Drs. Byers and Chen about the different immune mechanisms activated after an intradermal vaccination. Resp. Ex. C at 5. However, he argued that there is no evidence that the intradermal flu vaccine causes increased

cytokine responses compared to the intramuscular vaccination, and that the adaptive immune responses between the intradermal and intramuscular flu vaccines are comparable, thus the intradermal flu vaccine "is not more inflammatory than the intramuscular" vaccine. *Id.* at 6. He asserted that "the improved immunogenicity of the intradermal vaccination may be the result of improved antigen delivery to the draining lymph node." *Id.* at 5.

The medical literature filed in this case supports petitioner's experts' opinion that the intradermal flu vaccine causes a "heightened initial inflammatory immune response." The *Bragazzi* article explains, "….Fluzone ID seems to elicit temporary transcriptional changes in the circulating myeloid compartment. Vaccination upregulates modules linked to NF-*k*B-driven inflammation, IFN-γ response, TNF and CD40 signaling. These pathways are involved in T-cell activation and the development of adaptive immunity." Pet. Ex. 20, Tab L at 6. The *del Pilar Martin* article, referenced by Dr. Tompkins, examined local responses to microneedle influenza vaccinations, found "significant increases in the levels of cytokines IL-β, macrophage inflammatory protein 1 alpha, macrophage inflammatory protein 2, TNF-α, and monocyte chemoattractant protein 1 (MCP-1)" after a microneedle injection without the flu vaccine into the skin of mice. Resp. Ex. C, Tab 6 at 2. When the mice were injected with microneedles coated with flu vaccines, the cytokine levels "were further increased" and "enhanced at the 12-hour point." *Id.* The researchers wrote, "…these findings indicate that a rapid increase of cytokines at the insertion site was induced by [microneedle] mechanical skin penetration, which was enhanced upon antigen delivery. The skin cytokine profile analysis shows that skin immunization induces a local innate immune response and a release of chemokines in the skin suggestive of the activation and recruitment of immune cells to the site of vaccination." *Id.* at 2. In the discussion, *del Pilar Martin* explained, "Our analysis of cytokine expression in the skin following insertion of antigen-coated microneedles indicated the upregulation of IL-1β, TNF-α, and MIP-1α and supports the current models of Langerhans cell migration. The induction of the chemotactic proteins…suggests that following antigen-coated needle vaccination, the production of IL-1β and TNF-α in the skin is reinforced by recruitment of neutrophils and macrophages to the site of vaccination." Resp. Ex. C, Tab 6 at 5.

Both the *Bragazzi* and *del Pilar Martin* articles suggest an increase in proinflammatory cells after an intradermal vaccination, and that different complementary pathways are activated by the intradermal vaccination, which can lead to a more rapid and robust immune response. As *Bragazzi* observes, "muscle [is] quite inefficient to capture antigens and the IM route is therefore inferior to ID route in terms of biological mechanism and action." Pet. Ex. 20, Tab L at 6.

Additionally, Dr. Chen correctly observed that both injection site reactions and systemic reactions were higher compared to the intramuscular vaccination. *See* Pet. Ex. 19 at 3. The Fluzone Intradermal package insert provided that injection-site erythema, induration, swelling, and pruritus were all higher compared to the intramuscular flu vaccine. Resp. Ex. C, Tab 8 at 10. More people also reported headaches, shivering, malaise, and fever after receiving the intradermal flu vaccine compared to the intramuscular vaccination. *Id.*

The rapid upregulation of a pro-inflammatory response generated by the different immune cells resident between the intradermal layers leads to infiltration of the blood vessels at the site, leading to vasculitis that results in an ischemic injury, like brachial neuritis. Dr. Chen

explained the "presence of immune cells in the blood vessel of the injured nerve indicates that the mechanism of immune-mediated injury is a vasculitic process." *Id.* at 3. While Dr. Callaghan did not dispute Dr. Chen's characterization of brachial neuritis being a vasculitic neuropathy, Dr. Tompkins argued that "immune mediated brachial neuritis is mediated by an adaptive immune response," rather "than the innate response proposed by Dr. Chen." *See* Resp. Ex. E at 1; Resp. Ex. C at 4. He asserted that the biopsies of the brachial plexus from four patients found, "infiltrates [that] were predominately T and B cells, suggesting an adaptive immune response contributed to neuronal disease." Resp. Ex. C at 4.

Contrary to Dr. Tompkins' characterization of Drs. Chen and Byers' opinions, they did not assert that the vasculitic brachial neuritis was solely caused by the innate immune system's cells. Rather, as discussed above, Dr. Chen characterized brachial neuritis as inflammatory in nature. Dr. Chen explained that the *initial rapid* response by the non-specific cells of the innate immune system, such as the dendritic cells, macrophages, or natural killer cells, facilitates the recruitment of proinflammatory cells and T cells to the site of injury. Further, the *Suarez* article, cited by Dr. Tompkins, supports Dr. Chen's opinion. After examining four biopsies of patients with brachial neuritis, the authors wrote, "The main observation from this series of patients with [brachial neuritis] was the presence of prominent collections of *inflammatory cells (especially T lymphocytes) within the brachial plexus."* Pet. Ex. 38 at 1. Dr. Chen appropriately noted that within her area of specialty, neurology, as opposed to that of Dr. Tompkins it is easy to understand that neurologists do not biopsy nerves at the outbreak of a condition such as brachial neuritis but rather do so only after the condition has persisted for some time at which point the T cells may be more prominent. As Dr. Tompkins is not medically trained, and his opinions that verge into the specific neurologic processes are given little weight.

Finally, I have accepted that the influenza vaccine can cause brachial neuritis in *Echols*. In that case, the petitioner received an intramuscular flu vaccine, resulting in immediate pain followed by weakness that developed over a few days. *Echols v. Sec'y of Health & Human Servs.*, No. 17-838, 2021 WL 4891589 (Fed. Cl. Spec. Mstr. Sept. 14, 2021), *mot. for review denied*, 165 Fed. Cl. 9 (Mar. 9, 2023). In *Abels*, Special Master Dorsey, also accepted that the influenza vaccine can result in brachial neuritis due to both the activation of the innate and adaptive immune system. *See Abels v. Sec'y of Health & Human Servs.*, No. 18-558, 2022 WL 2036101 (Fed. Cl. Spec. Mstr. May 6, 2022). The opinions offered in this case as to how the intradermal flu vaccine can result in brachial neuritis is consistent with *Echols* and *Abels*.

Petitioner's experts in this case have proposed a sound and reliable theory, showing how the intradermal flu vaccine can result in brachial neuritis, thus satisfying *Althen* prong one.

2. *Althen* prong two

Under *Althen* prong two, petitioner must prove by a preponderance of the evidence that there is a "logical sequence of cause and effect showing that the vaccination was the reason for the injury. *Capizzano*, 440 F.3d at 1324 (quoting *Althen*, 418 F.3d at 1278). "Petitioner must show that the vaccine was the "but for" cause of the harm or in other words, that the vaccine was the reason for the injury.'" *Pafford*, 451 F.3d at 1356 (internal citations omitted).

In evaluating whether this prong is satisfied, the opinions and views of the vaccinee's treating physicians are entitled to some weight. *Andreu,* 569 F.3d at 1367; *Capizzano,* 440 F. 3d at 1326 ("[M]edical records and medical opinion testimony are favored in vaccine cases, as treating physicians are likely to be in the best position to determine whether a 'logical sequence of cause and effect show[s] that the vaccination was the reason for the injury.'" (quoting *Althen*, 418 F.3d at 1280)). The petitioner need not make a specific type of evidentiary showing, i.e., "epidemioligc studies, rechallenge, the presence of pathological markers or genetic predisposition, or general acceptance in the scientifici or medical communities to establish a logical sequence of cause and effect." *Capizzano,* 440 F.3d at 1325. Instead, petitioner may satisfy his burden by presenting circumstantial evidence and reliable medical opinions. *Id*. at 1325-26.

I find that petitioner has provided preponderant evidence of a logical sequence of cause and effect. This finding is based on expert opinion, petitioner's clinical course, petitioner's treating physician's opinion, and lack of evidence to support an alternative cause.

Petitioner's experts, Drs. Huffman, Byers, and Chen, all opined that petitioner's brachial neuritis began shortly after he received the flu vaccine. Pet. Exs. 8-10; 19, 25. Dr. Chen observed that petitioner had been diagnosed with diabetes for "up to two years prior to the flu vaccination…and had not developed any neurological complications." Pet. Ex. 19 at 3. Dr. Huffman, petitioner's treating orthopedist, outlined petitioner's clinical course and found it to be consistent with brachial neuritis. Dr. Huffman explained that when he first treated the petitioner on May 28, 2015, the petitioner described having immediate pain, swelling and the sensation of heat in his left shoulder following the flu vaccination. Pet. Ex. 8 at 2. Dr. Huffman stated that after petitioner underwent the circumferential capsular release and repair of the small rotator cuff tear in his left shoulder, petitioner's pain did not subside. *Id*. Dr. Huffman wrote, "While I was able to restore [petitioner's] passive shoulder motion, his pain did not subside and had a largely neurogenic component to it. Combined with focal weakness in his musculocutaneous nerve distribution, I ordered a neurologic evaluation." *Id*. The EMG on August 8, 2015 documented a severe, chronic musculocutaneous nerve neuropathy. *Id*. When petitioner was evaluated by neurologist, Dr. Zager, he was diagnosed with Parsonage Turner Syndrome. *Id.*; *see also* Pet. Ex. 23 at 10.

Respondent argued that petitioner cannot establish *Althen* prong two because the medical records do not demonstrate the temporal association between the October 2014 vaccination and the onset of his left arm pain and weakness. Resp. Brief at 19. More specifically, respondent argues that the January 19, 2015 medical appointment does not document that petitioner had left arm pain. *Id*. at 17; *see also* Pet. Ex. 2 at 84.

However, as Dr. Huffman observed, multiple medical records document the onset of petitioner's left arm pain and weakness as occurring shortly after the flu vaccination. *See* Pet. Ex. 2 at 89 (reporting left arm pain that started "back in Oct. a few days after got the flu shot); Pet. Ex. 6 at 29 (complaints of left shoulder pain which has been ongoing since October..2014…he had an influenza injection, that night he started having pain); and Pet. Ex. 23 at 10. Further, the record from March 2, 2015 actually documents that petitioner showed Dr. Peet a lump at the injection site. Pet. Ex. 2 at 89. Finally, the January 19, 2015 appointment

appears to be a diabetes follow-up, where the purpose of the visit was to review labs. Medical records are not presumed to be accurate and complete to document all physical conditions. *Kirby v. Sec'y of Health & Human Servs.*, 997 F.3d (Fed. Cir. 2021). Thus, it does not seem appropriate to ignore all the other medical records which document an association between the onset of petitioner's pain in his left arm and the flu vaccine because one intervening record failed to document petitioner's symptoms accurately.

Respondent also argues that petitioner's course is more likely consistent with diabetic cervical radiculoplexopathy. Resp. Brief at 20. As discussed above, I found that petitioner's injury was brachial neuritis, and not diabetic cervical radiculoplexopathy. *supra* at 28-29. Dr. Chen acknowledged that petitioner had poorly controlled diabetes for nearly two years prior to the vaccination but had not developed any neurological complaints. Pet. Ex. 19 at 5. Dr. Chen credibly explained that petitioner's brachial neuritis clinical presentation was more consistent with immune-mediated brachial neuritis than a diabetic radiculoplexus. *Id*. at 2.

Dr. Chen stated that "the prominent associated feature that is seen with diabetic radiculoplexus neuropathy…is the presence of weight loss (typically 15-30 lbs.) coinciding with the development of the neuropathy." Pet. Ex. 25 at 1. She observed that the medical records do not document any weight loss between April 2014 and March 2, 2015. *Id*. Additionally, Dr. Chen stated that petitioner's neuropathy was limited to his left arm, whereas diabetic radiculoplexus neuropathy there is often involvement of other body regions. *Id*. at 2.

Petitioner's clinical course was consistent with that of patients who experienced post-vaccination brachial neuritis as described in the medical literature submitted in this case. The *Shaikh* article describes a 46-year-old woman who described acute onset of pain a "few days after an influenza vaccination." Pet. Ex. 20, Tab E. Within a week of the onset of pain, she developed left-upper limb weakness with difficulty performing her usual activities. *Id*. The woman's cervical MRI ruled out cervical radiculopathy, but an EMG and NCS revealed severe axonal denervation of the left deltoid and supraspinatus muscles with mild involvement of the infraspinatus muscle and evidence of renervation. *Id*. at 1. The woman was diagnosed with post-vaccination acute brachial neuritis. *Id*. The authors explained that the "temporal pattern in our patient, of pain followed by weakness, is classic of brachial neuritis." *Id*. Further, the authors note that brachial neuritis is an uncommon condition that is often misdiagnosed. *Id*. at 1. As explained by *Van Alfen*, brachial neuritis has "core features that include episodes of extreme pain at symptom onset, rapid multifocal paresis (weakness) and atrophy of the upper extremity muscles, and a slow recovery requiring months to years." Pet. Ex. 20, Tab D at 1. In another article by *Van Alfen*, she explains that many patients with brachial neuritis also develop glenohumeral joint pathology after a brachial neuritis attack with weakness of the rotator cuff muscles or decreased glenohumeral excursions due to weakness, that can lead to frozen shoulder. Resp. Ex. C, Tab 3 at 4. Further, *Van Alfen* explains "misdiagnoses are frequent" in brachial neuritis cases. *Id*.

Petitioner consistently reported that his left shoulder pain began within a few days of receiving the influenza vaccination on October 22, 2014. On March 2, 2015, four months after the vaccination, petitioner had an appointment with Dr. Barmach with the family medicine practice Pet. Ex. 2 at 89. Under "Chief Complaint," it states, "a flu shot on 10/22/2014…the flu

shot was given in the left deltoid, about three days after injection, there was severe pain, redness and swelling. Was seen again on 01/19/2015 with Dr. Peet and showed him the lump that had lasted since [injection]." *Id*. Petitioner then reported that he had left arm/shoulder pain that was worse at night and that it had started a few days after he got the flu shot. *Id*. Additionally, petitioner reported that he had swelling around the deltoid which resolved, but he has some pain in the left side of his neck that can radiate down to his elbow, along with numbness in his left hand. *Id*. Petitioner stated that it hurt to move his arm in all directions and described the pain as "knife-like." *Id*. The physical exam revealed that petitioner had "palpable muscle spasm along the left trapezius," and he was "able to flex left arm about 80 degrees before it becomes too painful." *Id*. at 90. Dr. Barmach diagnosed petitioner with "brachial neuritis or radiculitis," and noted, "[patient] believes symptoms started after flu shot but I believe that is more coincidental. I believe symptoms due to neck pathology and getting radicular pain." *Id*. at 90. Petitioner was referred to an orthopedist for an evaluation and was prescribed methyl prednisone. *Id*.

On March 16, 2015, petitioner had an appointment with orthopedist, Dr. Diane Gracie. Pet. Ex. 3 at 5. Petitioner stated that he had been "experiencing left shoulder pain for the past 5 months," and that "he had a flu shot in October of 2014 and the pain seemed to start after that. He did have an area that was raised and swollen for awhile…..the pain now radiates down to his elbow. At times he has numbness in his hands. He took a 6-day Medrol Dosepak with no relief of his symptoms." *Id*. Of importance, Dr. Gracie found no cervical radicular findings, but petitioner did have a positive impingement sign and tenderness over the deltoid area. *Id*. Further, petitioner had restriction on internal rotation with his left thumb only going up to the sacrum. *Id*.

Petitioner saw orthopedist, Dr. Huffman, on May 28, 2015, after physical therapy had failed. Pet. Ex. 6 at 29. Dr. Huffman wrote that petitioner had "complaints of left shoulder pain which has been ongoing now since October of…2014." Pet. Ex. 6 at 29. Dr. Huffman also noted that petitioner "had an influenza injection….that night he started having pain and swelling, inflammation, and sensation of heat. The symptoms worsened progressively and ultimately, he was referred to an orthopedist." *Id*. Dr. Huffman noted that petitioner had pseudo-winging of the left scapula and a weak trapezius. *Id*. Dr. Huffman diagnosed petitioner with adhesive capsulitis or frozen shoulder "with onset temporally and most likely causally related to the influenza injection." *Id*. at 29-30. Petitioner had a cortisone injection, which apparently offered little relief. *Id*. at 31. Eventually, petitioner had a left shoulder arthroscopy on July 15, 2015. *Id*. at 39. Again, this surgical intervention did not provide much pain relief and Dr. Huffman described petitioner's pain as "neurogenic in nature." *Id*.

On August 18, 2015, petitioner underwent an EMG/NCS at the University of Pennsylvania. Pet. Ex. 6 at 9. Prior to the study, Dr. Shawn Bird performed a neurologic examination of petitioner's left shoulder and found that petitioner "appeared to be weak in the biceps muscle," and petitioner reported reduced sensation to light touch over all of his fingers in his left hand and in the anterior left forearm. *Id*. The nerve conduction study showed that, "The left lateral antebrachial cutaneous sensory response was absent," and, "the left median motor responses were notable for a prolonged distal latency." *Id*. Additionally, the EMG found, "evidence of severe chronic denervation in the left biceps muscle." *Id*.

When petitioner was evaluated by neurologist, Dr. Eric Zager on October 21, 2015, one year-post vaccination, petitioner again reported that that he had left arm pain and weakness that began when he received the flu vaccine in October 2014. Pet. Ex. 23 at 10. Dr. Zagar wrote that "within about a day of getting the injection he complained of left shoulder pain and swelling. His pain was so severe with movement he ultimately had frozen shoulder." *Id.* Dr. Zagar reviewed petitioner Parsonage-Turner syndrome. *Id.*

Petitioner's clinical course began with acute pain close in time to receiving the influenza vaccine, which developed into weakness shortly thereafter. Additionally, petitioner presented with a winged scapula, which *van Alfen* describes as "the most obvious sign of [brachial neuritis]." *See* Pet. Ex. 20, Tab D at 1. Petitioner had weakness in his thumb, index and third digit of his left hand. He also developed a loss of sensation in the fingers of his left hand which is consistent with *van Alfen's* statement that, "Sensory symptoms are usually inconspicuous, but most patients can recall paresthesia over the radial side of the thumb, index finger and forearm at onset." *See* Pet. Ex. 23 at 10; Pet. Ex. 20, Tab D at 2. Finally, because of petitioner's condition, he eventually develop frozen shoulder, which according to the medical literature is common in patients with brachial neuritis due to the pain being "persistent and more incapacitating." Pet. Ex. 20, Tab D at 2. It is common that patients experiencing such pain engage in pain protective behavior, that is not moving the arm, to minimize the painful symptoms which ultimately results in adhesive capsulitis which petitioner had developed by the time he saw Dr. Huffman.

Thus, after reviewing the evidence, I have concluded, consistently with the petitioner's treating neurologists and orthopedists as well as Dr. Chen, that petitioner developed brachial neuritis in his left shoulder as a result of receiving the intradermal flu vaccination. Petitioner's onset of pain and clinical course progression was consistent with the literature discussed above. Additionally, I find respondent's theory that petitioner's brachial neuritis was more likely diabetic cervical radiculopathy unpersuasive, as petitioner never experienced complications or symptoms prior to receiving the vaccination at issue. As such, petitioner has satisfied *Althen* prong two.

3. *Althen* prong three

Althen prong three requires petitioner to establish a "proximate temporal relationship" between the vaccination and the injury alleged. *Althen,* at 1281. That term has been defined as "medically acceptable temporal relationship." *Id.* The petitioner must offer "preponderant proof that the onset of symptoms occurred within a timeframe which, given the medical understanding of the disease's etiology, it is medically acceptable to infer causation-in-fact." *De Bazen,* 539 F.3d at 1352. The explanation for what is a medically acceptable time frame must also coincide with the theory of how the relevant vaccine can cause the injury alleged (due to *Althen* prong one). *Id.*; *Koehn v. Sec'y of Health & Human Servs.,* 773 F.3d 1239, 1243 (Fed. Cir. 2014); *Shapiro v. Sec'y of Health & Human Servs.*, 101 Fed. Cl. 532, 542 (2011), *recons. denied after remand*, 105 Fed. Cl. 353 (2021), *aff'd mem.,* 503 F. App'x 952 (Fed. Cir. 2013).

Prior to the vaccination on October 22, 2014, petitioner had no physical limitation or injuries to his left shoulder. Petitioner reported that he had pain following the flu shot at multiple appointments, including one on March 2, 2015 with Dr. Barmach, then again on April 16, 2015

to Dr. Gracie, and also to Dr. Huffman on May 28, 2015. *See* Pet. Ex. 2 at 89; Pet. Ex. 3 at 7; Pet. Ex. 6 at 29. At each of these appointments, petitioner reported that he experienced pain soon after the flu vaccine was administered, and that he had swelling and a sensation of heat at the injection site. Further, petitioner consistently reported that his pain progressed over the next few days post-vaccination. Pet. Ex. 2 at 89. Petitioner's pain did not subside, and he also demonstrated weakness in his left arm. Pet. Ex. 3 at 11. Even after a shoulder arthroscopy to release his frozen shoulder, petitioner's pain remained. He was diagnosed with brachial neuritis after an EMG/NCS evaluation by Dr. Shawn Bird. Pet. Ex. 6 at 43.

Petitioner's medical records consistently record that he experienced an adverse reaction at the injection site, which consisted of pain and a sensation of heat at the injection site, followed by progressive pain his left shoulder. Dr. Byers explained that an injection site reaction, such as swelling or erythema, can often be transient and is "characteristic of vaccines." Pet. Ex. 9 at 7. Thus, it appears that petitioner experienced an immediate transient injection site pain, and then the pain associated with his brachial neuritis developed over two- or three-days post-vaccination.

Drs. Byers, Chen and Huffman all agree that the pain petitioner experienced that was relatable to his brachial neuritis occurred very close in time to the vaccination. Dr. Chen opined that the onset of petitioner's brachial neuritis was three days and is consistent with a rapid inflammatory response that contributed to the development of a local vasculitic process. Pet. Ex. 19 at 3. Dr. Byers also opined that a rapid initiation of the pro-inflammatory cytokines in the dermis led to nerve and tissue damage. Pet. Ex. 9 at 5.

Dr. Tompkins acknowledged that the "timing of onset of symptoms [of brachial neuritis] after events ranged from less than 24 hours to more than two weeks." Resp. Ex. C at 3. He stated that "the window between preceding events and onset of [the] disease ranges from hours to weeks," however, he argued that the rapid onset of symptoms is not because of an innate immune response, but rather an adaptive immune response. *Id.*

I have accepted petitioner's mechanism as to how the intradermal flu vaccine can cause brachial neuritis. Petitioner's experts' opinions that the onset of petitioner's pain, two- or three-days post-vaccination, the first manifestation of brachial neuritis, is consistent with the onset of immune-mediate brachial neuritis as explained in the medical literature and the findings of an appropriate temporal association between the flu vaccine and the onset of brachial neuritis. Additionally, respondent's expert, Dr. Tompkins does not dispute that the onset of pain, the first symptom of brachial neuritis can occur rapidly after an inciting event. *See* Resp. Ex. C at 4 (noting that "the window between preceding event and onset of [brachial neuritis] ranges from hours to weeks.").

In the *Shaikh* article, the authors described the onset of the patient's pain after the influenza vaccine as being "acute, developing a few days after an influenza vaccination." Pet. Ex. 37 at 1. The authors of that article explained that the exact etiology of brachial neuritis is unclear, but "is thought to be an immune-mediated inflammatory reaction against brachial plexus nerve fibers involving complement, anti-peripheral nerve myelin antibodies and T cells." *Id.* at 1-2. *van Alfen* found that 53% of patients reported an antecedent event prior to the onset of the brachial neuritis, and nearly all of those events, including vaccination or infection, occurred in

the week preceding the initial attack, with 17.4% of patients reporting that the event occurred only hours before onset. Resp. Ex. C, Tab 3.

Other cases in the Vaccine Program also have found that an appropriate temporal association between the flu vaccine and the onset of brachial neuritis is within a few hours post-vaccination to a few days. For example, in *Echols*, I found that the onset of symptoms occurring within hours of the flu vaccination and progressing over several days, was medically acceptable to infer causation. *Echols v. Sec'y of Health & Human Servs.,* at *23. In *Abels*, the special master found that the onset of pain two days after the influenza vaccine, which progressed to weakness approximately six days later was an appropriate temporal association between the vaccination and the onset of brachial neuritis. *Abels v. Sec'y of Health & Human Servs.*, No. 18-558V, 2022 WL 2036101, at *21 (Fed. Cl. Spec. Mstr. May 6, 2022).

I find it acceptable that inflammation would cause the onset of pain within 2-3 days of the intradermal influenza vaccination, and the progression of pain and weakness over several days to be an appropriate temporal association between vaccination and the onset of brachial neuritis. Petitioner has established *Althen* prong three.

V. Conclusion

For the foregoing reasons, petitioner is entitled to compensation for brachial neuritis and adhesive capsulitis caused by the October 22, 2014 intradermal influenza vaccine. A separate damages order will be issued.

IT IS SO ORDERED.

s/Thomas L. Gowen
Thomas L. Gowen
Special Master